# FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS


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FIFTEENTH ANNUAL MEETING
*June 12-16, 1955*
Columbus
Ohio


Pages 271-318

June, 1955 Volume 9, Number 6

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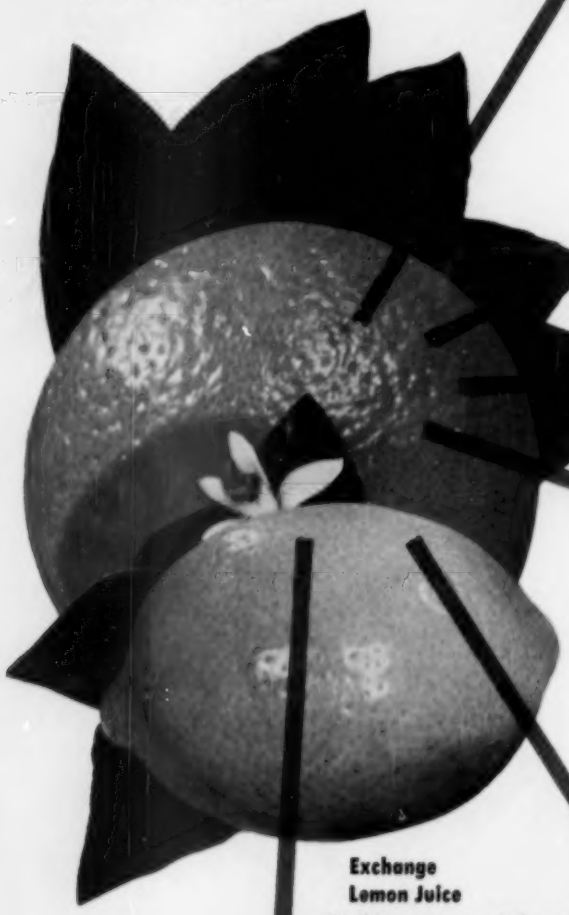

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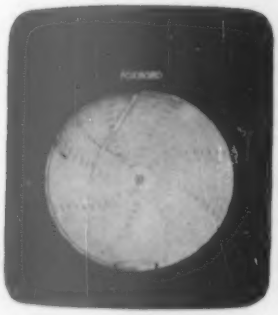

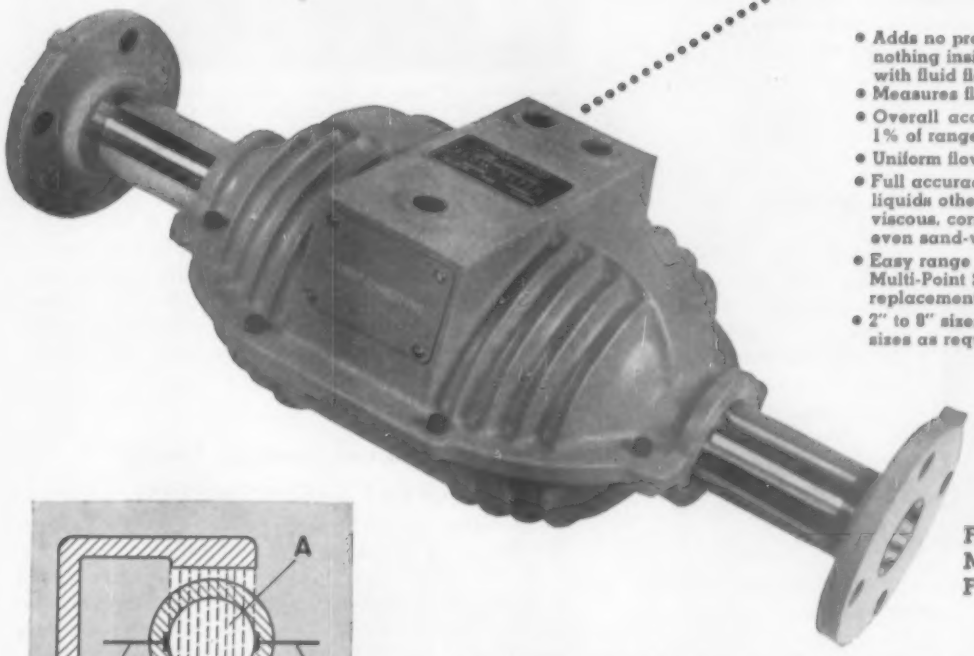

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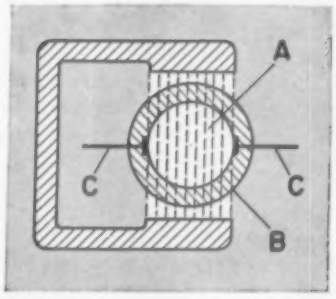


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# Affairs of the Institute

Annual Meeting Bulletin Board
To Be Honored at Fifteenth Annual Meeting
Regional News
Personnel
The Samuel Cate Prescott Award
Selected Abstracts
Books
Recently Elected Members
Food Industry Topics
Future Meetings

## Annual Meeting Bulletin Board

The opening general session of the 1955 IFT program scheduled for Monday morning, June 13, provides for the remarks of welcome and the announcements.

President Bates' message on the "State of the Union" will be one of the features of this session and should be of interest to all members.

Dr. Philip K. Bates, President of the Institute of Food Technologists, will complete a successful term of office with the close of the annual meeting on June 16. Under Dr. Bates' leadership the Institute has continued its steady growth and begins its sixteenth year well prepared for an expanding role in the field of food research and technology.

The rest of the session has been "themed" with the customer, or ultimate consumer in mind on the premise that the Food Technologist is interested in "the customer's" reactions and habits. The effectiveness of his efforts, the degree of acceptance enjoyed by his products depend on what the customer thinks. And yet in many instances the Food Technologist is not as well attuned to her as he would like to be. With this in mind, two dynamic speakers have been enlisted to speak from two widely divergent viewpoints with "The Great American Customer" in mind.

From the vantage points of serving as Dean of the College of Agriculture, The Ohio State University, Director of the Ohio Agricultural Experiment Station and a long association with agricultural production, Dean L. L. Rummel can be depended upon to provide much food for thought in discussing "Research For The Great American Customer."

Mr. Stephen A. Douglas, Director of Advertising and Sales for The Kroger Company, has had a long association with the field of retail food distribution. Out of that experience he has made a keen analysis of the customer and has become intimately acquainted with her. With a degree of insight, enthusiasm and conviction that is typical of him, Mr. Douglas will discuss "The Great American Customer" in a fashion which should be stimulating and challenging to all who hear him.

**Buckeye Bull Being Fattened for IFTers**

**Dave Nay, William J. Stange, District Representative and a member of IFT Publicity Committee with Bob Craft, Supt. of David Davies Meat Packing Co., selecting one of the Prize Buckeye Grown Steers for the June 13th IFT Ox Roast.**

Come to the 1955 IFT meeting early. Plan to attend the opening general session on June 13. It will be different. It will be informative. It should be profitable!

Time has been reserved at the end of the morning session for a short announcement by Dr. Roy C. Newton concerning the activities of the Committee set up under the National Academy of Sciences to study civil defense problems relating to foods.

## Regional Section News

### GREAT LAKES SECTION

The Great Lakes Section, IFT met at the William Pitt Hotel in Chatham, Ontario, Canada, April 15, 1955. Before the meeting, most everybody who attended the meetings enjoyed a trip through the American Can Company factory and the Hinde and Dauch paper box factory. The members were escorted through both factories in small groups and were allowed to ask any number of questions. Everybody talked about the courteous treatment and enjoyed the trips and gifts from Hinde and Dauch.

The meeting was called to order by Chairman Thompson at 2:30 p.m. and turned over immediately to the program chairman, Mr. Alexander.

Mr. Paul J. Bernard, the speaker, was well informed on cartons for vacuum cooled leafy vegetables and gave us some valuable information. There are two good sized vacuum cooling units in Canada and Hinde and Dauch have worked out the cartoning problem with them. The process has no adverse effect on lettuce or other leafy vegetables. The loss through evaporation is not over 2% and is cheaper than any other method.

Mr. Ferguson, co-author with Dr. A. H. Jones, gave a paper on factors contributing to flat sour spoilage of tomato juice. He said the microorganism causing flat sour is present in the tomato wash water across Canada and was in greater numbers early in the season. He stated that various strains of organisms had differing ability to initiate spoilage and that other factors besides acidity must be taken into consideration. Good sanitary

(Continued on page 10)

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# To Be Honored at Fifteenth Annual Meeting of IFT

**Well known from coast to coast and beyond our national borders in their respective fields, Dr. Charles Glen King, Nutrition Foundation, Inc., New York, and Dr. William V. Cruess, the University of California, Davis, are the 1955 recipients of the top honor awards of the Institute of Food Technologists. Awards, like the paintings of old masters, take on luster with each passing year and with each new awardee. The achievements of the honors nominees for 1955 can only be touched upon in these few paragraphs, but here are some background facts that can be added to your program notes.**

## The Appert Medalist

### Dr. Charles Glen King

IT HAS BEEN OBSERVED BEFORE—but many of the grandsons and great-grandsons of the young men who took Horace Greeley's advice, "Go West," reversed that order and travelled the trails "back East." No exception was Charles Glen King, who spent his early years in Entiat, Washington, on the family fruit and livestock farm. Perhaps his interest in food began with his close contacts with these two commodities. He made a start eastward, still in his early youth, and travelled first as far as Kansas where he picked up some basic information on another great commodity, wheat, on a ranch in that state. In 1914 he returned west to Washington for his college work. Entering Washington State College in Pullman, he majored in science, attaining the degree of bachelor of science from that institution in 1918. In that same year he headed east again, for further college work, and matriculated at the University of Pittsburgh. In 1920 he was graduated as a master of science and three years later, in 1923, he was awarded his doctorate.

From his first post in the Chemistry Department in 1920, he proceeded up through the ranks at the University of Pittsburgh, reaching a full professorship in the 1930's. During his career at Pittsburgh Dr. King made major contributions to both chemistry and nutrition. His contributions to chemical theory are exemplified, perhaps, by his work on the molecular structure of fats, and it is of interest that distinguished work in this field has been continued at the University of Pittsburgh by his students and former associates. Dr. King's outstanding work as a teacher should not be overlooked in recounting his claims to distinction.

**"Out of life's school and into the school of life . . . "**

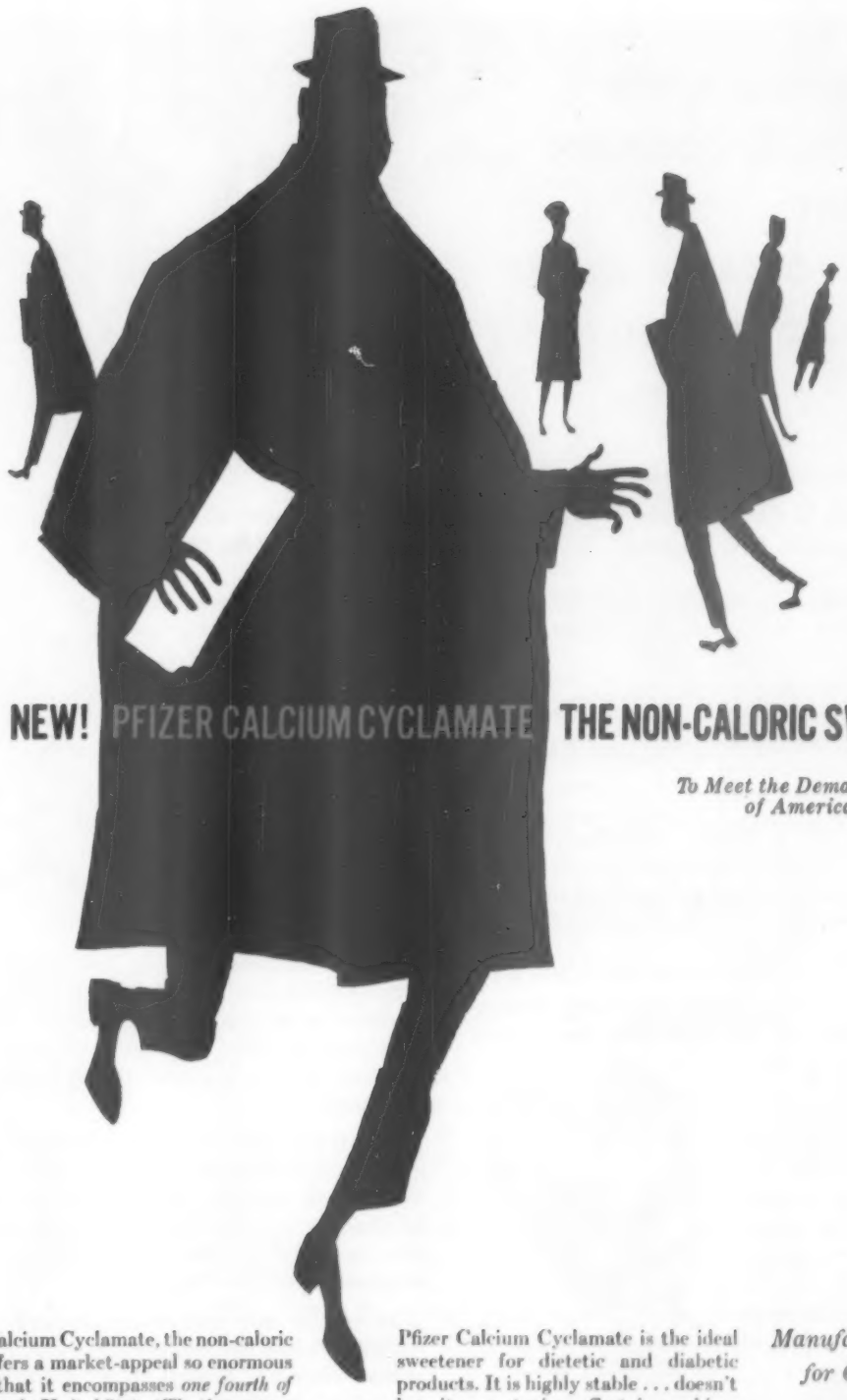
Dr. King's isolation and identification of vitamin C is well known. With the Wisconsin group and with others both here and abroad who were vastly excited about vitamins during the period between the World Wars, he helped to open up this new and important field, a field which has since developed into what is almost a subscience of its own.

Dr. King's contacts with the food industry began early in his career and have continued down the years. At Pittsburgh he acted as consultant to a number of food companies and, as head of the Nutrition Foundation, he has constantly kept touch with the industry and its enormous progress. The role of industry in achieving for America high nutritional status for its massive population is well recognized by Dr. King. He also has noted the ironic fact that "the best fed nation on earth" is not immune to nutritional imbalance—for the reason that our citizenry have such a plenty to choose from that they eat only what they like!

Does this man of science have interests outside of the literature on biochemistry, his preoccupation with nutrition, and his zeal to educate America in the simple principles of better nutrition?

A visit to his home in Scarsdale, New York, would reveal one—growing roses. With his wife, Hilda, he has

(Continued on page 8)



# NEW! PFIZER CALCIUM CYCLAMATE THE NON-CALORIC SWEETENER

*To Meet the Demands of America's "Heavy" Market*

New Pfizer Calcium Cyclamate, the non-caloric sweetener, offers a market-appeal so enormous in potential that it encompasses *one fourth of all the adults in the United States!* That's approximately 34,000,000 overweight or diabetic consumers who avoid sugar-sweetened food and drink . . . and may be avoiding yours.

This addition to Pfizer's expanding line of food and beverage ingredients is introduced at a most favorable time. For this *big volume, high profit* dietetic market is now at an all-time high! What an opportunity to "jump in" at exactly the right moment with *your* cyclamate-sweetened food or beverage product!

Pfizer Calcium Cyclamate is the ideal sweetener for dietetic and diabetic products. It is highly stable . . . doesn't lose its sweetening effect in cooking, baking, canning or freezing. It is a safe, pure and sure sweetener, salt-free to meet strictest diet requirements. It does not impart a bitter off-taste or after-taste to your product, and it's compatible with all flavorings.

Look into Pfizer Calcium Cyclamate now. Contact Pfizer for full details, a working sample and counsel on your plans for launching a full scale or test-market product, aimed at those millions who count their calories!

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# WHY SHOULD THE VITAMIN C CONTENT OF FRUIT AND VEGETABLE JUICES BE STANDARDIZED?

***Because nutrition reports disclose that—***

- **Vitamin C deficiencies exist throughout the country***
- **Scurvy has not disappeared from the United States***

**Proof of deficiencies among adults and children.** You should know these facts!* Diet surveys from Maine and Vermont, New York, Illinois, New Mexico, Oregon, West Virginia, and Texas show a definite pattern of inadequate vitamin C intake. These studies covered grade school and high school children, college men and women.

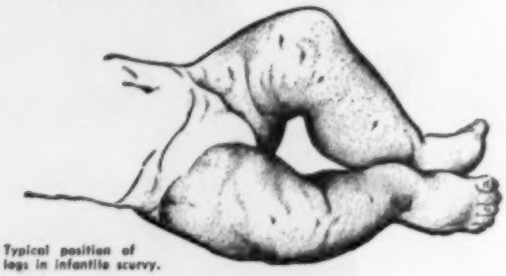
Spongy, swollen gums symptomatic of scurvy.

From these studies* of dietary habits and physical conditions there is considerable proof that many of the children and adults covered by survey have actual, physical symptoms of vitamin C deficiency.

**Infantile scurvy.** Scurvy* occurs, even today, among infants who are artificially fed. Fortunately the disease may be cured by the administration of vitamin C. How much more sensible it is to prevent it by supplying these bottle-fed infants with the daily allowance of 30 milligrams of vitamin C as recommended by the Food and Nutrition Board of the National Research Council for children under one year of age.

Symptoms of infantile scurvy are fretfulness and fear of being touched.

These bottle-fed infants, unless receiving a pediatric prescription containing vitamin C, are largely dependent on supplemental ascorbic acid which they receive from fruit or vegetable juices. Unless fortified with vitamin C many of the processed juices may not supply these babies with adequate quantities of this essential element.



Typical position of legs in infantile scurvy.

**What can be done?** Because of the increasing evidence that American diets are deficient in vitamin C, leading nutrition experts believe that processed fruit and vegetable juices, on which the public is so reliant for its supply of this necessary vitamin, should contain the "Vital Ingredient."

The Vital Ingredient of any processed fruit or vegetable juice is a *dependable* and *adequate* supply of vitamin C. You can give your juice this ingredient by *standardizing its vitamin C content*. The processing is simple and the new low cost of ascorbic acid makes juice standardization more attractive than ever.

With ascorbic acid available *by the tons* at extremely modest cost fruit and vegetable juices can have a standardized vitamin C content for the better protection of the nation's health and well-being.

*Statements are based on documented reports. References on request.

Illustrations after photographs in The Vitamins in Medicine by Bicknell and Prescott, Third Edition, published by Grune & Stratton, Inc., New York.

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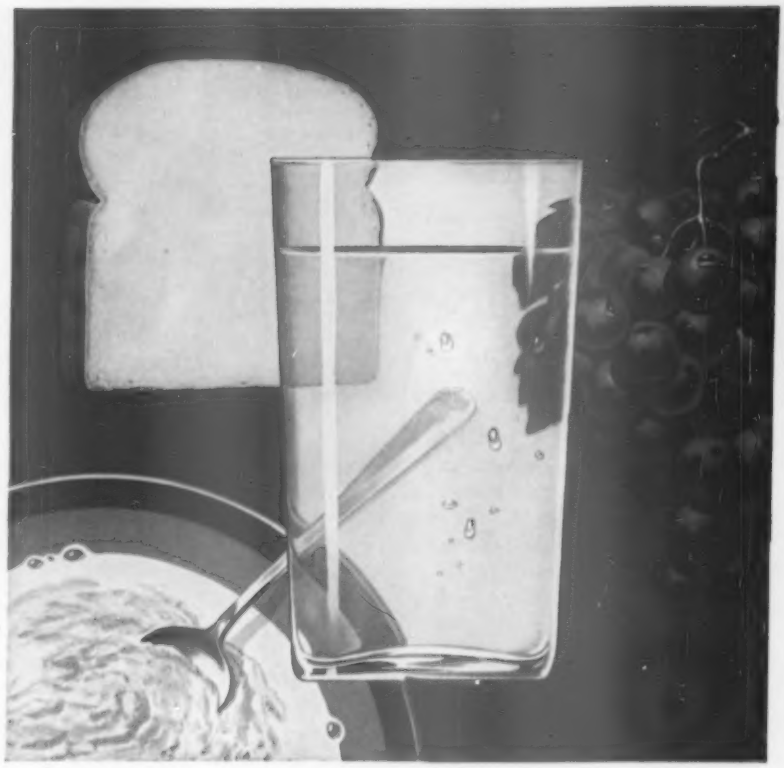

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**LACTASE • CELLULASE • LIPASE**

Rohm & Haas commercial enzymes are all natural products . . . and among the most effective aids in food processing.

They are easy to use and are well suited to the mild processing conditions common to the food industry. In service they provide many benefits. For example, they clarify fruit juices, aid in the production of pre-cooked breakfast cereals, improve the texture of bread, and make possible "non-sandy" ice cream of higher skim milk content.

Rohm & Haas enzymes catalyze specific reactions; unwanted by-products are not formed. And little enzyme goes a long way toward increased production efficiency and greater consumer sales appeal.

**Write to Department SP outlining your food processing problem.**

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. . . he won a case of wheaties . .

almost succeeded in surrounding his home with a rose garden populated with the choicest varieties of that beautiful flower.

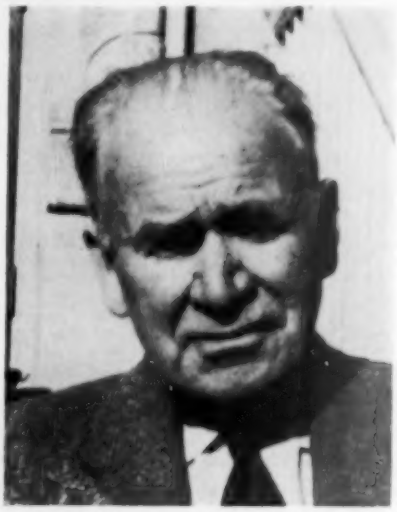
Trout fishing ranks high among Dr. King's sports interests. Opportunities to indulge in this sport have come along rather infrequently during these later years, however, and so there are trout flies and lures and fancy fishing gadgets that stay at home in Scarsdale and never get near the water.

Since we are on the subject of sports, it might be appropriate to make brief mention of another and earlier sports interest—tennis. The accompanying picture, a memento from a sojourn to a Johns Hopkins seminar on Gibson Island in 1936, shows Dr. King after a triumphant set with a colleague. A few days after winning this match, Dr. King received at his home in Pittsburgh an appropriate award—a full case of the breakfast food of champions!

In honoring Dr. King with the Appert Medal, the Chicago chapter of IFT signalizes the contributions of a man of versatile attainments in the food and nutrition sciences. As a writer of scientific articles, as a speaker, as a teacher, and as an executive of a great foundation, the 1955 recipient of the Appert Award has been, and is, a great force for human betterment.

## The Babcock-Hart Award Winner

### Dr. William V. Cruess



THE FORTY-NINERS, of course, went West years before Horace Greeley sounded his ringing cry. Dr. William V. Cruess, Babcock-Hart Award Winner for 1955, the great-grandson of a Forty-niner, has remained in California steadfastly throughout his long and distinguished career. This probably means, more than anything else, that the tie that binds Californians to California is hard to break—especially so if you are a Native Son of Native Sons.

Dr. Cruess, the details of whose career were written up in the February issue of FOOD TECHNOLOGY, has exercised a deep and abiding influence on the technology of preservation as it relates to horticultural crops. Like Dr. King, he has communicated his ideas and his findings in many ways—as a teacher (from 1912 to date), as a writer (through articles, bulletins, circulars and books) and as a speaker (before local and national professional groups). Few men have followed so closely as Bill Cruess the roles of the various factors that cause fruit and vegetable products to deteriorate, the opportunities for exploiting unexpected commercial values in such crops, and the dietary resources of these commodities.

When Dr. Cruess steps forward to receive the distinguished Babcock-Hart Award, he will in truth have contributed to "better nutrition by outstanding accomplishments in food science and technology."

## The Food Engineering Award Honors the Peebles Process

EACH BIENNIUM *Food Engineering*, noted food journal of the McGraw-Hill Book Company, sponsors an award which is given to a company which has developed a novel process of food manufacture or improved an existing one. The process must have been in commercial use prior to the granting of the award. The selection is made by a Jury of Award appointed by the President of the Institute.

This year's award honors the Peebles Process, a method for producing a quickly dispersed, free-flowing, non-foaming, non-fat dry milk with a fresh milk flavor. Mr. Frank Lawler, editor of *Food Engineering*, will present the award at the 15th annual meetng of IFT in Columbus. D. D. Peebles of the Western Condensing Company, Petaluma, California, will describe the process in a speech to be delivered before the food engineering session of the annual meeting.

# Announcing the 1955 Glycerine Research Awards

| | | |
|---|---|---|
| **FIRST AWARD** | **Honor Plaque** ..... | **$1,000** |
| **SECOND AWARD** | **Honor Certificate** ..... | **$300** |
| **THIRD AWARD** | **Honor Certificate** ..... | **$200** |

The purpose of this group of awards, established in 1952 by the Glycerine Producers' Association, is to recognize and encourage research leading to new and improved applications of glycerine or glycerine derivatives to products or processes. The work may concern itself with the chemical, physical or physiological properties of glycerine, or with properties of glycerine-containing or glycerine-derived materials. It may deal with applications which of themselves are currently or potentially of value to industry or the general public, or it may deal with scientific principles or procedures likely to stimulate future application. Originality in extending the application of glycerine into new fields of usefulness will receive special consideration for awards.

## BASIS OF ENTRY

These awards are open to any individual in the United States and Canada engaged in research, whether employed in industry or affiliated with a governmental or educational institution (faculty or college student) except those connected with member companies of the Glycerine Division, Association of American Soap & Glycerine Producers, Inc., or laboratories which they employ. (Joint entries by research teams or associates of two or three individuals are also eligible.)

## PERIOD OF AWARD

First consideration for the 1955 Award will be given to work which has come to a successful conclusion or clear-cut point of accomplishment during the current year, regardless of the date at which the work was initiated. Work carried on in previous years, but the significance of which has been confirmed by commercial application in 1955, will be eligible.

## JUDGES

Selection of award winners will be made by a committee of three judges of outstanding reputation and appropriate scientific background, having no connection with the Association or its members.

## DATE FOR NOMINATIONS

All nominations for the 1955 awards must be received by *November 1, 1955.*

## METHOD OF NOMINATION

Only nominations made on the official entry blank will be eligible for awards. For a copy of this official entry blank, write to: *Awards Committee, Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.*

## REGIONAL SECTION NEWS

(Continued from page 2)

practices with proper processing temperatures and prompt cooling were necessary to prevent spoilage.

Dr. J. H. L. Truscott gave an interesting talk on "Fruit Juice Viscosity as an Indication of Maturity." After mentioning the shortcomings of respiration, pressure test, sugar, acid, pH, ground color and others he outlined this new method. He picked a sample, cut it in half inch cubes, cooked it 10, 20, 30 or 50 minutes, pressed out the juice at 6000 p.s.i. and centrifuged this product. The clarified juice was drawn up into a microbiological pipette and the time recorded for it to drop four inches. He had charts illustrating his results which were very interesting.

Dr. V. J. Oswald delivered an enlightening talk on the making of imitation flavors. He took us through the job of choosing a select panel of tasters chosen for their ability and not a trained group. And then through the building up of an imitation flavor from the many available. Starting with a few that lead in the right direction and adding this or that to build up a full imitation flavor which he said in many cases was as good or better than flavors extracted from horticultural material. He also brought up flavors that might be developed to push through a masking material such as starch, milk, etc. He regretted that some of the old synthetics which were poorly made had developed in people a dislike for artificial flavors.

The after dinner speaker, Mr. Don Henshaw, gave a vivid picture of the good relationship between Canada and the United States. He emphasized the fact that these two great democracies living side by side had proved that people with dissimilar governments could live peacefully and be of value to each other. The meeting came to a close about 8:30 p.m.

## NEW YORK SECTION

**More Food Technology Needed in Formosa and Ceylon.** Primitive food-processing methods, low sanitary standards, and resistance to technological improvement must be overcome if technical aid is to improve the diets of underdeveloped countries.

These significant first-hand observations in Formosa and Ceylon were stressed by Drs. David B. Hand and Zoltan D. Kertesz at the April 20 meeting of the New York Section of the Institute of Food Technologists.

Formosa, said Dr. Hand, is burdened by overpopulation, lack of heavy industry, and an economy geared to the production of only three commodities—sweet potatoes, rice, and sugar.

There is no unemployment problem, because the Formosan government rigidly controls labor. But this perpetuates inefficient processing methods which easily could be mechanized. As as example, Dr. Hand cited a soy sauce factory in which some 40 girls filled bottles manually. When it was pointed out that a single automatic filler could do the job, the plant manager agreed but said that this would lead to unemployment.

Lack of heavy industry has created an unfavorable trade balance, hence the need for developing new export products as well as consumer goods to diversify the rice-based Formosan diet. Although widespread undernourishment is not evident, protein intake seems to be inadequate.

Conditions on Ceylon are similar in many respects, according to Dr. Kertesz. Under British rule, Ceylon became an exporter of rubber, tea, and copra, while growing little for domestic needs. Meanwhile, the jungle steadily reduced available acreage, so a major reclamation project is needed.

Foods are processed as they were hundreds of years ago, with little regard to sanitation. Canning is done only on a very small scale, and Dr. Kertesz cited inadequate transportation facilities as a prime cause of fresh-food spoilage.

Perhaps the greatest single problem is that of orienting a people to the methods of modern technology. This must not be attempted at a greater rate than is indicated by their capacity for change, the speaker concluded.

Both speakers, who have traveled extensively for the government on technology problems overseas, are affiliated with the N. Y. Agricultural Experiment Station, Geneva. Dr. Hand has recently returned from an FAO tour of Formosa, while Dr. Kertesz worked in Ceylon for the UN.

## PHILADELPHIA SECTION

The following officers were elected at the April 5 meeting to serve for the 1955-56 term:

Chairman: Louis W. Mable.
Vice-Chairman: Edwin C. Dryden.
Secretary: Norman Kramer.
Treasurer: William H. Knightly.
National Councilor: John P. Crimmins.
Executive Committee (2-year term): C. B. Darlington, Richard L. Mullan.

The Eastern Regional Research Laboratory of the U. S. Department of Agriculture was host to the section at this meeting. Dr. W. P. Ratchford, Technical Assistant to the Chief of the Laboratory, greeted the members and explained briefly the organization and functions of the laboratory. A 90-minute tour of the laboratory followed, in which short talks and demonstrations were given by a number of the research workers. Topics discussed included new products from vegetables, maple syrup, concentrated and dehydrated fruit juices, Potato flakes, and dairy waste disposal. Various items of laboratory and pilot-plant equipment were explained and demonstrated. Numerous food items were available for tasting. Members of the section were enthusiastic in their praise of the work of the laboratory.

## NORTHEAST SECTION

The April meeting of the Northeast Section was held at the M.I.T. Faculty Club on April 7, 1955.

The speaker of the evening was Mr. Howard L. Green, manager of Marketing Research of Stop & Shop, Inc., one of the largest retail self-service supermarket chains in New England. Mr. Green presented an excellent discussion on the many problems associated with

(Continued on page 12)

# How to woo the diet shopper

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*She knows* SUCARYL; *she's used it in her home.*

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Of course, you won't know this until you try it. And we would like to have you try SUCARYL—with our compliments—in your product. No obligation. Just tell us whether you prefer SUCARYL Sodium or SUCARYL Calcium, and write to: Chemical Sales Division, Abbott Laboratories, North Chicago, Illinois. Abbott

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## REGIONAL SECTION NEWS

(Continued from page 10)

the retail marketing of a variety of products, all of which are competing for shelf-space.

In March, the Northeast Section published the first edition of its directory of members, which was sent to each section member.

Also in March, a Placement Committee of the Section was announced with Mr. W. P. Hinkley, New England District Engineer of the Cherry-Burrell Corporation, in charge.

Election of officers for 1955-56 took place with the following slate:

Chairman: E. E. Lockhart.
Vice-Chairman: W. L. Cummings.
Secretary: E. Barron.
Treasurer: A. S. Levine.
National Councilor: L. B. Sjöström.
Sectional Councilors: J. H. Moriarty, E. Anderson.

## PERSONNEL

The appointment of Roy H. Walters, director of research and development, to a vice presidency in the General Foods Corporation was announced in April by the Board of Directors of that Corporation. Mr. Walters began his career with General Foods in 1934 in the research department at Battle Creek, Michigan, transferred to the Central Laboratories, Hoboken, New Jersey, in 1939. In 1951, after acquiring wide experience in directing the work of various divisions of the Central Laboratories, he was appointed director of research and development for General Foods. Mr. Walters has long been active in IFT and other professional groups. He is currently president of the Research and Development Associates, Food and Container Institute, a non-profit organization with industry-wide membership which provides technical counsel and other services, on invitation of Quartermaster Corps officials, to the Armed Forces.

## ANNOUNCEMENT OF SAMUEL CATE PRESCOTT AWARD COMPETITION FOR STUDENT MEMBERS OF THE INSTITUTE OF FOOD TECHNOLOGISTS

The Samuel Cate Prescott Award in Food Technology was established by the Northeast Section of The Institute of Food Technologists to honor Doctor Samuel Cate Prescott, outstanding research worker in the field of Food Technology, and outstanding teacher with a great interest in youth.

This award, given for the purpose of stimulating the interest of young men and women in Food Technology, is offered annually by the Northeast Section of The Institute of Food Technologists for the best written account of a research project in the field of Food Technology. This may be, preferably but not necessarily, a research project conducted by the author.

Those eligible for the competition include all student undergraduates who are members of the Institute in good standing, who are rated as seniors during the academic year 1954-1955, and who will receive a Bachelor's Degree in Food Technology prior to July 1, 1955. This Degree shall be represented by training in such courses as physics, chemistry, mathematics, bacteriology, and engineering fundamentals.

The prize shall be: ONE HUNDRED DOLLARS.

The Committee reserves the right to withhold any award if none of the papers are of the quality deemed satisfactory by the judges.

Competitors are to submit their written papers to:

Mr. James Donovan, N. E. Section, IFT
c/o Artisan Metal Products, Inc.
73 Pond Street, Waltham 54, Massachusetts

previous to December 1, 1955.

The essay shall be submitted in duplicate, typewritten on paper of good quality, double-spaced, and not less than six nor more than fifteen pages in length.

# Selected Abstracts*

## ANALYTICAL METHODS

**pH and food processing.**

Evans, R. S., and Cantab, B. A. *Food Manuf., 30,* 5-10 (1955).

The author comprehensively reviews the applications of pH measurement in almost all branches of food manuf. He commences with a description of modern instruments and then deals in turn with the various food industries.

**Determination of easily hydrolyzable fructose units in dextran preparations.**

Wise, C. S., Dimler, H., Davis, A., and Rist, C. E. *Anal. Chem., 27,* 33-6 (1955).

A qual. procedure was developed to detect as little as 0.01% free or easily liberated fructose in dextran samples. The two quant. colorimetric methods which were developed measure, in addn., at least part of the fructose in such compds. as melezitose and leucrose, from which it is difficultly liberated. The method using a modified anthrone reagent also is particularly suitable for quant. paper chromatography of fructose. In both this and a modified resorcinol method the color-forming power of glucose is limited to about 1/240th that of fructose.

**Report of the committee on joint collaborative work of the A. O. A. C. - American Oil Chemists' Society on total nitrogen in feeds and fertilizers.**

*J. Assoc. Offic. Agr. Chemists, 38,* 56-61 (1955).

The results clearly indicate the superiority of Hg over Cu as a catalyst for digestion of samples in the detn. of total N. Although boric acid has been gaining favor over standard acids for absorption of $NH_3$, the collaborative results fail to support its use. Until a further study is made the decision as to the time required for digestion should be left to the discretion of the analyst.

## BIOLOGICAL SCIENCES

### BIOCHEMISTRY

**Sources of error in microbiological determinations of amino acids on acid hydrolyzates. II. Apparent loss of amino acids on storage.**

Horn, M. J., Blum, A. E., Gersdoff, C. E. F., and Warren, A. W. *Cereal Chem., 32,* 64-70 (1955).

If acid hydrolyzates of raw and cooked barley are not filtered properly and assayed at once, certain amino acids tend to dis-

* These Selected Abstracts are made available to Food Technology through the cooperation of Dr. H. A. Campbell and the General Foods Corporation of White Plains, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 14)

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## SELECTED ABSTRACTS

(Continued from page 12)

appear from the hydrolyzates after storage at pH 6.8 under toluene at room temp. Rates of loss vary with different amino acids, depending on the food. This loss is apparently not due to bacterial decompn. Filtration at pH 4.0 removes the material responsible for these losses. With this technic, satisfactory recoveries of amino acids have been made from carbohydrate-contg. foods, acid-hydrolyzed separately and together.

**The lipotropic activity of protein.**

LUCAS, C. C., AND RIDOUT, J. H. *Can. J. Biochem. Physiol., 33,* 25-30 (1955).

A distinct lipotropic effect of casein has been observed in rats under conditions that appear to preclude any explanation involving the methionine or choline content of the ration. Diets low in protein produce a type of fatty liver that is not prevented by choline and is histologically different from that of choline deficiency. Choline appears less effective in such diets than in ones more adequate in protein. Presumably choline has only a limited effect on abnormal fat in periportal regions because the biochem. basis of this lesion seems to involve faulty formation of lipoprotein due to shortage of essential amino acids.

**The influence of water and pH on the reaction between amino compounds and carbohydrates.**

SCHROEDER, L. J., IACOBELLIS, M., AND SMITH, A. H. *J. Biol. Chem., 212,* 973-83 (1955).

The effect of $H_2O$ and pH on browning and the Maillard reaction was studied by comparing model amino acids and synthetic peptides autoclaved with and without glucose in the dry state and in buffered solns. Browning appears to be due to the effect of pH on carbohydrates only and not to the interaction, the Maillard reaction, is limited and takes place in alk. solns. These findings were substantiated by chromatographic analyses and the total *N* and amino *N* detns.

**Positional asymmetry of fatty acids on lecithin.**

HANAHAN, D. J. *J. Biol. Chem., 211,* 313-19 (1954).

Natural occurring lecithins of beef, rabbit, dog, guinea pig and rat livers have been purified and the positional asymmetry of their fatty acids detd. For all species the $\alpha'$-ester position was found to possess an unsatd. and the $\beta$-ester position a satd. fatty acid. Details are given for prepn. of (Distearoyl)-L-$\alpha$-lecithin and monostearoyllecithin.

**Protein synthesis in the cell nucleus.**

MAZIA, D., AND PRESCOTT, D. M. *Nature, 175,* 300-1 (1955).

The results described seem to demonstrate unequivocally the existence of protein synthetic mechanisms that are assocd. with the nucleus.

**Observations on the collagen system.**

RANDALL, J. T. *J. Soc. Leather Trades Chemists, 38,* 362-87 (1954).

A review of work done by the author during recent years including some electron micrographs.

**Structural units in collagen fibrils.**

NORTH, A. C. T., COWAN, P. M., AND RANDALL, J. T. *Nature, 174,* 1142-3 (1954).

It was shown that the polypeptide chains within the well-ordered interbands almost certainly have a helical configuration. The diffuseness of the high-angle pattern, however, indicates that these crystn. regions are of small extent, perhaps only 50 A. long.

**In situ indicator technic, a new principle in histochemical localization of enzymes.**

WATTENBERG, L. W. *Proc. Soc. Exptl. Biol. Med., 87,* 535-8 (1954).

As an illustrative example of this type of technic, succinic dehydrogenase has been demonstrated in tissue sections with neotetrazolium chloride serving as the *in situ* indicator.

**The action and properties of beta-amylase: recent developments.**

HOPKINS, R. H. *Wallerstein Labs. Communs., 17,* 299-316 (1954).

The mechanism of amylopectin hydrolysis is discussed. The extent of hydrolysis of amylose dialyzates and residues by $\beta$-amylase is described. Evidence for and against the identity of the Z-enzyme is presented. The Z-enzyme has been postulated as necessary to enable $\beta$-amylase to complete its hydrolysis.

**Demonstration of an oligosaccharide intermediate in the enzymatic hydrolysis of cellulose.**

HASH, J. H., AND KING, K. W. *Science, 120,* 1033-5 (1954).

Cellulose action on cellulose in the past has reduced only cellobiose and glucose. In order to demonstrate intermediate products, it was found necessary to incubate enzyme and substrate in a collodion sac. Concn. of the dialyzate followed by paper chromatography showed the presence of a third sugar tentatively identified as cellotetraose. This expt. supports the hypothesis of random cleavage by the enzyme.

### BOTANY

**Developmental morphology of the kernel in grain sorghum.**

SANDERS, E. H. *Cereal Chem., 32,* 12-25 (1955).

The development of the endosperm, seed coat, and pericarp to gain a more thorough understanding of the kernel structures important in wet milling are discussed.

### MICROBIOLOGY

**Salmonella isolations from dehydrated dog meals.**

GALTON, M. M., HARLESS, M., AND HARDY, A. V. *J. Am. Vet. Med. Assoc., 126,* 57-9 (1955).

*Salmonella* were isolated from 26 (26.5%) of 98 samples of dog meal, but none were found in 54 samples of pressed foods (dog "bones" biscuit, flakes, kibbled products) or 7 samples of dog "candy." Those products contg. the largest known amts. of meat meal (12.5% to 25.0%) commonly yielded *Salmonella.* The 2 brands of dog meal which failed to yield *Salmonella* are sterilized at sufficient temp. and time to kill these organisms.

**A bacteriological study of cottage cheese with particular reference to public health hazard.**

LYONS, P. R., AND MALLMANN, W. L. *J. Milk and Food Technol., 17,* 372-6 (1954).

The pH of a bland cottage cheese lies within the range tolerating the coliform organisms. With coliforms as the indicator, the data show that cottage cheese may well be considered a potential public health hazard. Nearly all samples of bulk packaged cottage cheese were heavily contaminated with coliform organisms.

**Classification and identification of yeasts. Part II.**

LODDER, J., AND KREGER-VAN RIJ, N. J. W. *Lab. Practice, 4,* 20-4 (1955).

A discussion of the genera and species belonging to the two families, *Saccharomycetaceae* and *Sporobolomycetaceae.*

### NUTRITION

**Antibiotics, growth, food utilization and the use of chromic oxide in studies with rabbits.**

HUANG, T. C., ULRICH, H. E., AND MCCAY, C. M. *J. Nutrition, 54,* 621-30 (1954).

When terramycin or aureomycin was fed at levels ordinarily recommended for other species of animals, no growth improvement was shown for young rabbits fed a pelleted natural ration.

**The nutritional properties of killed Bacterium coli.**

ROBERTS, R. S. *Brit. J. Nutrition, 8,* 353-62 (1954).

Cultures of *B. coli* prepd. by the aeration or vortex-stirring technics were centrifuged and the cells killed by heating at 80° C. for 1 hr. The resulting prepn. which contained 80% protein was mixed with cereals and fed to chicks and rats. The

(Continued on page 16)

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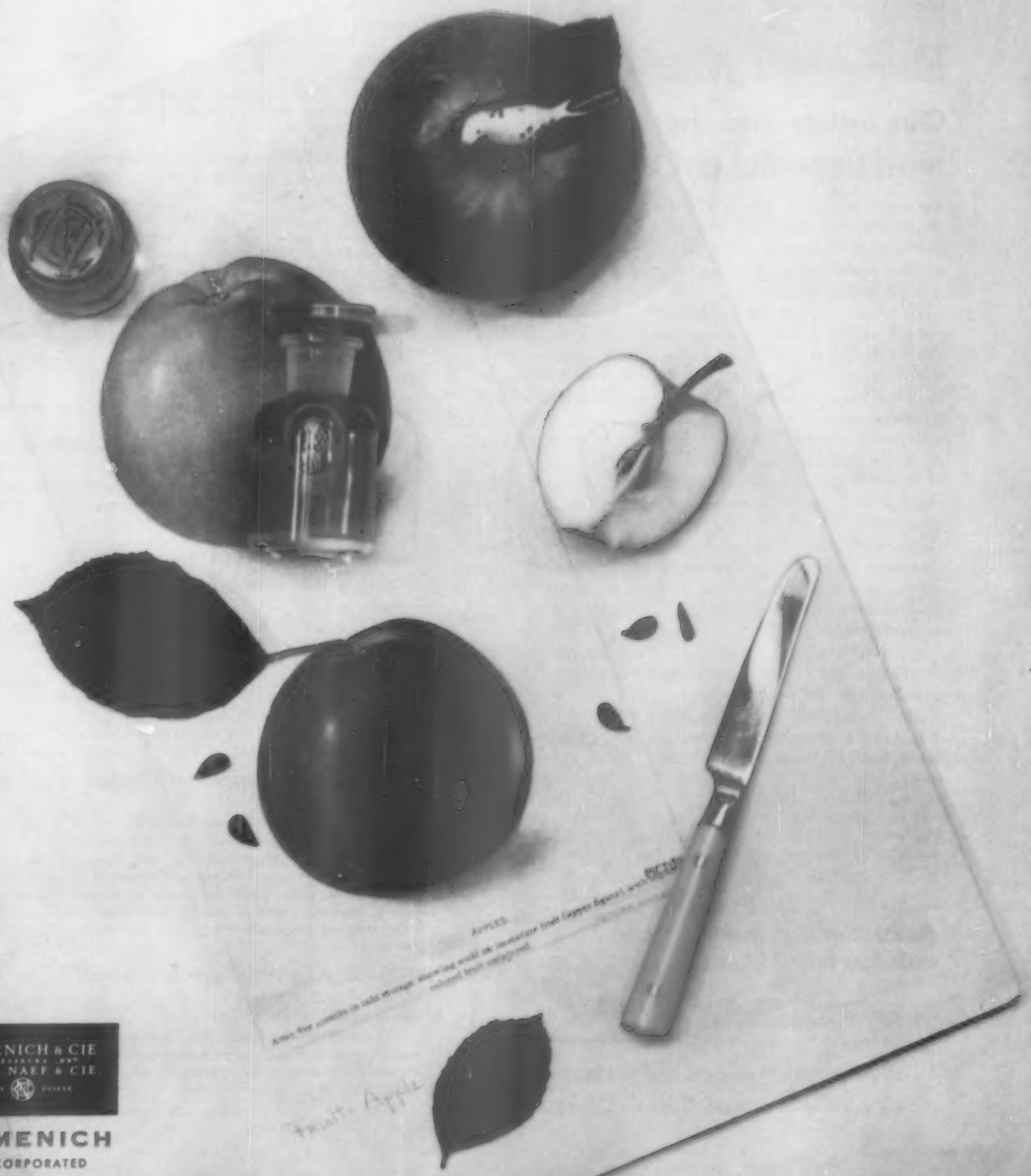


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## SELECTED ABSTRACTS

(Continued from page 14)

growth promoting ability of *B. coli* appeared to be greater than that of the conventional animal proteins. It was suggested (1) that this and the beneficial effects of antibiotic feeding may be related phenomena and (2) that *B. coli* may be used as a food organism.

### PHARMACOLOGY AND TOXICOLOGY

**The physiological activity of substituted phenols. II. Relationships between physical properties and physiological activity.**

Blackman, G. E., Parke, M. H., and Garton, G. *Arch. Biochem. Biophys., 54,* 55-71 (1955).

For some *32* substituted phenols the equi-effective concns. required (a) to produce a standard degree of chlorosis in *Lemna minor* or (b) to halve the growth rate of *Trichoderma viride* have been correlated with the variations in soly. and the dissocn. const. As the no. of Cl atoms or alkyl group substituents is increased or alkyl side chain lengthened, there is an inverse linear relationship between the logarithms of the relative biol. activity and soly.

**The chronic oral toxicology of the polyethylene glycols.**

Smyth, H. F., Carpenter, C. P., and Weil, C. S. *J. Am. Pharm. Assoc., Sci. Ed., 44,* 27-30 (1955).

Polyethylene glycols were fed in the diet to rats for 2 yrs. and to dogs for 1 yr. Apparently a compd. with a mean mol. wt. of 6,000 is definitely less toxic by mouth than those of lower mol. wts. This work supports the view that the polyethylene glycols may be considered inert when taken by mouth.

**Carcinogenicity of fats "browned" by heating.**

Lane, A. C. *Dissertation Abstr., 14,* 2381 (1954).

It was concluded that the overheating of fat produces a low grade carcinogen.

**Route of absorption and distribution of oleic acid and triolein in the rat.**

Bergstrom, S., Blomstrand, R., and Borgstrom, B. *J. Biol. Chem., 58,* 600-4 (1954).

There is no detectable difference between the routes followed during absorption of fed free oleic or palmitic acids, or of glycerides contg. these acids.

### PHYSIOLOGY AND MEDICINE

**A theory of taste stimulation.**

Beidler, L. M. *J. Gen. Physiol., 38,* 133-9 (1954).

The treatment in this paper of available quant. data on the response of taste receptors to Na salt stimulation clearly indicates that the ions of the chem. stimulus are loosely bound to some substance of the taste receptor. This can be thought of as an initial reaction which ultimately leads to stimulation of the receptor and an eventual depolarization of the assocd. sensory neuron. The speed of the total reaction suggests that the receptor substance is located on or near the surface of the receptor.

**The capillary syndrome in viral infections: treatment with citrus flavonoids.**

Sokoloff, B. *Am. J. Digest. Diseases, 22,* 7-9 (1955).

Citrus flavonoids, otherwise known as vitamin "P" or capillary permeability factor, minimize the injury to the capillary wall induced by viral infections. Five cases of virus influenza were treated with citrus flavonoids with encouraging results. The therapeutic effect of flavonoids in viral infections might be interpreted as the result of improved functioning of the capillary system.

**Utilization and intestinal excretion of calcium in man.**

Blau, M., Spencer, H., Swernov, J., and Laszlo, D. *Science, 120,* 1029-31 (1954).

The rate of absorption and utilization of ingested Ca, the excretion of digestive juice Ca into the gastrointestinal tract and its reabsorption were measured with a $Ca^{45}$ technic and metabolic balances.

(Continued on page 18)

The price of vitamin A in bulk is now little more than one-quarter of what it was in 1948. This suggests new consideration of vitamin A enrichment decisions.

1948 was the year when, under the trade-mark "Myvax," the first man-made vitamin A became available on the American market in commercial quantity. For a current quotation on it in individual containers of Myvapack Vitamin A, each premeasured for one batch of an individual food product, write *Distillation Products Industries*, Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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## SELECTED ABSTRACTS

(Continued from page 16)

## ENGINEERING AND PLANT EQUIPMENT

**Evaluating performance characteristics of mechanical mixing processes: the dextrose-kaolinite-water system.**

MICHAELS, A. S., AND PUZINAUSKAS, V. *Chem. Eng. Progr., 50,* 604-14 (1954).

Variables affecting rate of mixing and a measure of mixing uniformity are discussed. [This might be useful for work with doughs and pastes.]

**Dispersant cuts cost of spray drying.**

*Chem. Eng., 62,* 118*, January, 1955.

Tetrasodium pyrophosphate (0.2% based on solids content), acting as a dispersant, turns a high solids content filter cake of aluminum silicate into a free flowing slurry. Doubling the % solids concn. still yields a less viscous slurry.

## FOOD AND FOOD TECHNOLOGY

### BAKING AND BAKERY PRODUCTS

**Evaluation of cake flours.**

BENNETT, R., AND DEVLIN, J. J. *Food Manuf., 29,* 479-82* (1954).

Lab. tests established for evaluating baking properties of flour used in bread making, do not apply in the case of cakes. It is necessary to specify type of flour to be used for each type of cake. Effects of granulation, starch rupture, pH, degree of gelatinization and several other objective measurements are discussed. "Tailor-made" flours give best results with certain recipes. It may be possible to compromise on flour quality to yield reasonable results with most recipes, although not excelling in any.

**The concentration of a factor in soft wheat flours affecting cookie quality.**

YAMAZAKI, W. T. *Cereal Chem., 32,* 26-37 (1955).

Addns. of a purified starch tailings fraction to cookie flour resulted in greater ability to hydrate and a detrimental effect on cookie spread. The starch tailings were purified mainly by removing the granular starch.

**Problems of viscosity and consistency in baking.**

WINTERBERG, K. H. *Kolloid Z., 139,* 66-74 (1954).

General and specific rheological problems of the baking industry are discussed; measuring methods are surveyed and their practical application is critically evaluated.

### GELATIN

**A study of gelatin molecules, aggregates and gels.**

BOEDTKER, H., AND DOTY, P. *J. Phys. Chem., 58,* 968-83 (1954).

The presentation is divided into 3 parts: the characterization of gelatin mols., the aggregation of gelatin in dil. solns., and the light scattering and structure of gelatin gels.

**Studies of the cross-linking process in gelatin gels. III. Dependence of melting point on concentration and molecular weight.**

ELDRIDGE, J. E., AND FERRY, J. D. *J. Phys. Chem., 58,* 992-5 (1954).

A method of calcg. the heat of reaction for the cross-linking process from the dependence of the m.p. temp. on gelatin concn. or on wt.-av. mol. wt. is also presented.

### MILK AND MILK PRODUCTS

**Improving curd-forming properties of homogenised milk.**

MAXCY, R. B., PRICE, W. V., AND IRVINE, D. M. *J. Dairy Sci., 38,* 80-6 (1955).

Reduction of curd tension may be caused by adsorption of casein on newly created surfaces of fat during homogenization. Concg. the milk, adding low heat dry milk solids or low heat concd. skim milk may restore curd tension to homogenized milk.

**The influence of some surfactants upon the self-dispersion and churning of whole milk powder.**

MATHER, D. W., AND HOLLENDER, H. A. *J. Dairy Sci., 38,* 217-23 (1955).

Combinations of polyoxyethylene fatty acid esters and sorbitan fatty acid esters were instrumental in making a whole milk powder that was self-dispersible and did not churn when reconstituted.

**Effect of antioxidants in the control of oxidized flavor development in stored frozen cream. II. Use of ethyl hydrocaffeate.**

GELPI, A. J., BRYANT, E. W., AND RUSOFF, L. L. *J. Dairy Sci., 38,* 197-201 (1955).

In glass containers a 0.004% level of Et hydrocaffeate (I) was effective in delaying oxidized flavor development in stored frozen cream for a period of 12 mos. In the presence of 0.5 p.p.m. of Cu in glass containers, 0.04% and 0.02% concns. of I were effective through a 12-mo. period, but the 0.004% concn. was effective for a period of only 1 mo. In metal containers I was not as effective as in glass, and in the presence of Cu only the 0.04% concn. of I prevented the oxidized flavor for a 12-mo. period. Ascorbic acid at levels of 20, 25, and 40 mg./l. actually accelerated the oxidized flavor. Ascorbic acid added to I produced a synergistic effect, so that a 0.04% concn. of I and 25 mg./l. of ascorbic acid prevented the development of the oxidized flavor in cream stored in tinned cans, with and without 0.5 p.p.m. of Cu, for a 12-mo. period.

### POTATOES

**Potato composition. Survey of major and minor sugar and starch components of the white potato.**

SCHWIMMER, S., BEVENUE, A., WESTON, W. J., AND POTTER, A. L. *J. Agr. Food Chem., 2,* 1284-90 (1954).

Quant. and qual. analyses have confirmed that sucrose, fructose, and glucose comprise the major sugars of the white potato. Neither the amylose-amylopectin ratio nor the P content of the starches isolated from the potatoes was affected by storage time and temp. A study of various starch dispersion procedures has defined optimum conditions of solubilization of potato starch for starch-iodine "blue value" detns.

**Potato quality. VIII. Effect of foliar applications of sequestering and chelating agents on after-cooking darkening.**

SMITH, O., AND MUNETA, P. *Am. Potato J., 21,* 404-9 (1954).

Several sequestering and chelating agents were able to prevent or reduce after-cooking darkening.

### SEASONINGS

**MSG's power to perk up foods.**

GIRARDOT, N. F., AND PERYAM, D. R. *Food Eng., 26,* 71-2*, December, 1954.

Results of the Quartermasters investigation of the addn. of MSG are given. 25 out of 50 foods were improved. Levels are given.

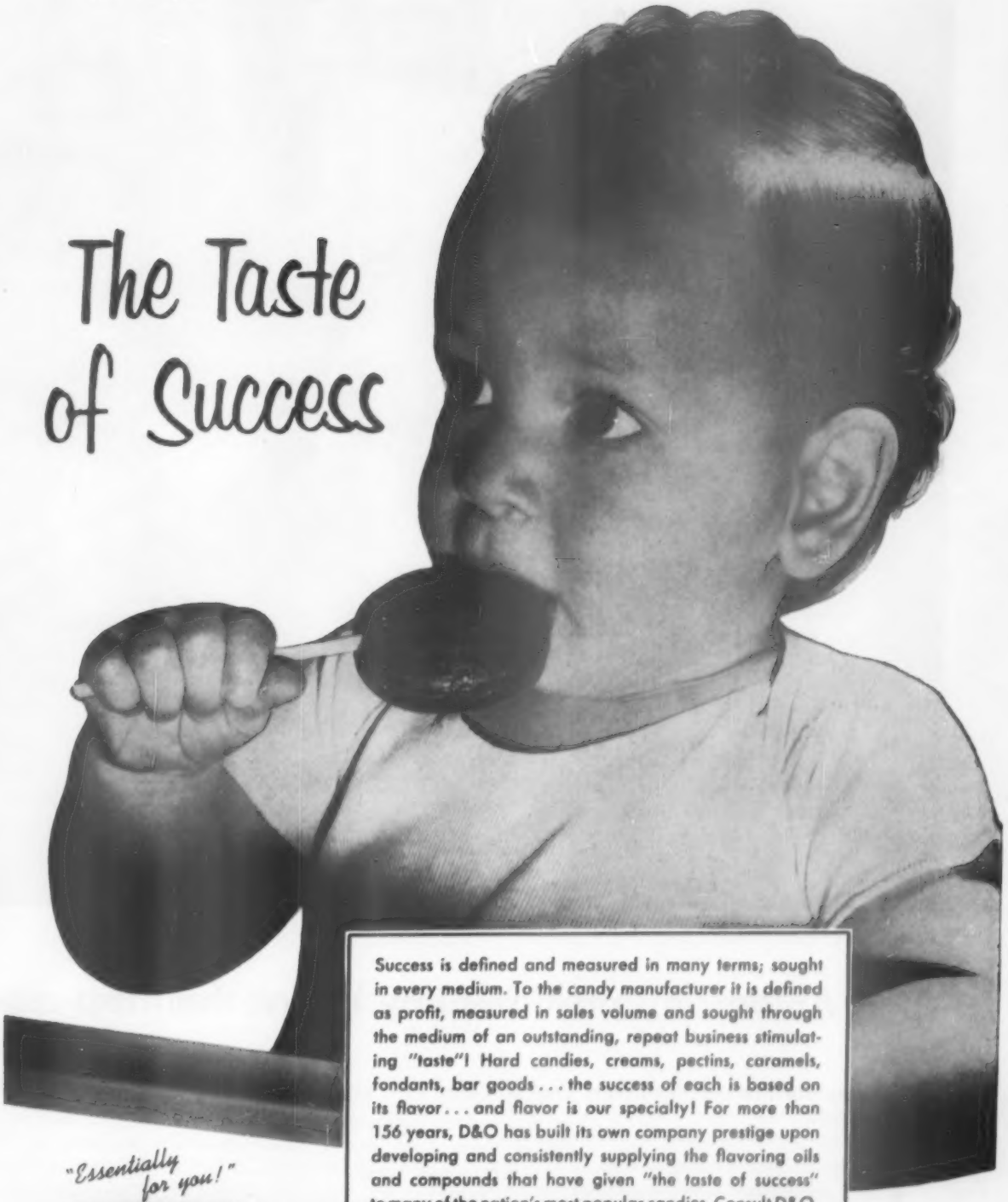
## ORGANIC CHEMISTRY

**The enzymatic synthesis and degradation of starch. Part XIX The action of R-enzyme on glycogen.**

PEAT, S., WHELAN, W. J., HOBSON, P. N., AND THOMAS, G. J. *J. Chem. Soc.,* 4440-5 (1954).

R-Enzyme, which debranches amylopectin, does not exert a similar hydrolytic action on the glycogen from oysters or from rabbit liver. This lack of action is probably due to the higher degree of branching of the glycogen and consequently to the greater compactness of the mol. which makes the majority of the branch links inaccessible to the enzyme. Thus the action of R-enzyme provides a simple practical method of distinguishing amylopectins from glycogens.

(Continued on page 22)



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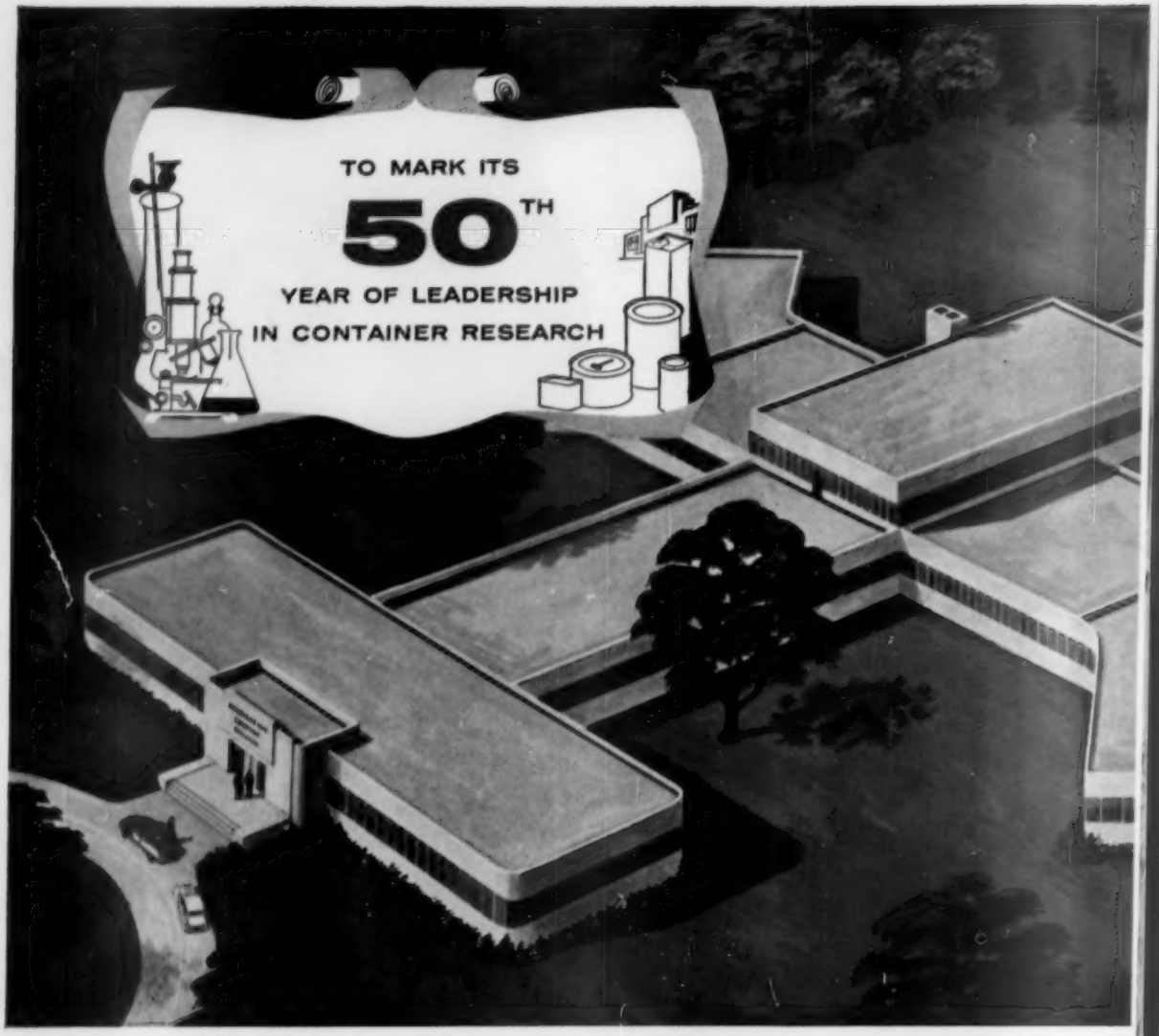


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## SELECTED ABSTRACTS

(Continued from page 18)

**Aging and "retrogradation" of starch solutions.**

ULMANN, M. *Kolloid Z., 140,* 32-41 (1955).

Aging of starch solns. consists of a series of overlapping processes. Changes in the 2 systems, amylopectin – $H_2O$, and amylose – $H_2O$ can be recognized simultaneously by means of starch chromatography ($Al_2O_3$-columns). The process of aggregation may lead to pptn. of amylose that has been contaminated by traces of amylopectin. Furthermore, amylopectin as well as amylose will eventually suffer structural changes as evidenced by their altered adsorptive behavior toward $Al_2O_3$. Simultaneous disaggregation may produce dextrins and other iodine-negative low mol. compds. especially in dil. solns.

## PHYSICAL RESEARCH

**Odor and molecular vibration. I. Quantum and thermodynamic considerations.**

WRIGHT, R. H. *J. Appl. Chem., 4,* 611-15 (1954).

If it is theorized that odor can be attributed to mol. vibrations, then it can be shown on quantum and thermodynamic studies that the frequencies involved lie in the i.r. range.

**The viscoelastic properties of aqueous soap gels.**

PILPEL, N. *Trans. Faraday Soc., 50,* 1369-78 (1954).

Gel formation takes place as a result of interlinking throughout the material of long, threadlike soap micelles.

**Viscosity and molecular weight.**

UMSTAETTER, H. *Kolloid Z., 139,* 120-4 (1954).

The math. relationships between viscosity and mol. wt. are discussed. The viscosity method is compared with the osmotic method of detg. mol. wt.

**Stability and thixotropy of montmorillonite suspensions.**

BUZAGH, A. *Kolloid Z., 139,* 74-81 (1954).

The author stresses the importance of reduced mobility due to steric hindrance among particles; the degree of dispersion is an important variable and ranks next to chem. compn.

## SANITATION

**Modern disinfectants. Suggested specification for the buyer of institutional disinfectants.**

KLARMANN, E. G. *Modern Sanitation, 6,* 15-18, December, 1954.

This communication contributes certain suggestions for modern disinfectant specifications which will take into account the several developments referred to above, in order to enable the progressive purchaser to keep abreast of these newer facts so that, in turn, the institution served by him may receive the benefit of the usage of more modern, more effective and more acceptable disinfectant products and procedures.

## PATENTS

**Drying method and apparatus.**

BISHOP, H. B. Assignor to Instant Drying Corp. *2,698,815,* January 4, 1955.

In spray drying the process which comprises dispersing the material to be dried in rotary manner and in finely divided form at a position near the top of a drying chamber, delivering a drying gas and a high speed stream of an aeriform suspension of previously dried dust into the chamber at a level at least approx. as high as the position of dispersion of the material to be dried, causing the mixed drying gas, dust suspension, and the material to intermingle in a turbulent generally horizontal movement, causing particles of the dried material to settle in the chamber, and then removing the coated, dried material from the chamber.

**Method of controlling shrinkage in Irish potatoes.**

KELLER, H. J. Assignor to Clinton Foods Inc. *2,698,246,* December 28, 1954.

A method of reducing the shrinkage in Irish potatoes for a period of time, comprising the step of subjecting the potatoes, to an atm. contg. an admixture of ethylene dichloride and trichloroethane in a ratio of about two parts of the former to about one part of the latter, both by wt. in the liquid form.

**Process for the treatment of whey.**

DE GOEDE, B. Assignor to Nederlandse Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek. *2,695,235,* November 23, 1954.

A process of producing a liquid substance having substantially the foaming and heat coagulating properties of natural egg white from a liquid milk whey comprising the steps of cooling the liquid milk whey to a temp. sufficiently low to cause pptn. of a part of the lactose from the liquid milk whey; alkalinizing the thus cooled liquid milk whey to a pH value between 11-12; acidifying the thus alkalinized liquid milk whey to a pH value between 9-10.5 so as to promote the separability of solids present in the liquid milk whey; and sepg. the solids and the pptd. lactose from the liquid whey, the thus remaining protein soln. having the foaming and heat coagulating properties of natural egg white.

**Vitamin composition.**

BAVLEY, A., AND TIMBECK, A. E. Assignors to Chas. Pfizer & Co., Inc. *2,702,262,* February 15, 1955.

A highly stable vitamin compn. which comprises a gelled matrix of gelable colloid selected from the group consisting of gelatin, agar, pectin and mixts. of these, with a sugar plasticizing material, the matrix contg. in dispersion finely divided particles of a solid soln. of a fat-sol. vitamin selected from the group consisting of vitamins, A, D and E, in hydrogenated oil which has a m.p. of at least about 40° C.

**Stabilized monoester compositions and method of making the same.**

KUHRT, N. H. Assignor to Eastman Kodak Co. *2,701,769,* February 8, 1955.

The method of stabilizing a monoglyceride compn. obtained by reacting a higher fatty acid triglyceride with glycerine in the presence of an ester-interchange catalyst which comprises admixing glycine and phosphoric acid with the monoglyceride compn. and maintaining the resulting mixt. for a substantial time within the temp. range 50-90° C.

**Dry imitation vinegar and process of making the same.**

KMIECIAK, T. C., AND FARRELL, K. T. *2,696,441,* December 7, 1954.

A dry rehydratable condiment compn. comprising glacial acetic acid, malic acid, lactose, and fruit essence, the condiment being characterized by a vinegar flavor upon rehydration.

## FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

| | |
|---|---|
| **1955** | |
| June 8-10 | Eighth Annual Meeting, Research and Development Associates, Food and Container Institute, Inc., Chicago, Illinois (together with Radiation Sterilization of Foods Symposium, June 10, 1955). |
| **June 12-16** | **Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio** |
| June 20-23 | American Dairy Science Association, June 20-23, East Lansing, Michigan |
| September 5-9 | American Institute of Biological Sciences, Michigan State College, East Lansing, Mich. |
| September 5-9 | American Society for Horticultural Science, Michigan State College, East Lansing, Mich. |
| September 6-8 | Mycological Society of America, Michigan State College, East Lansing, Michigan |
| September 11-16 | American Chemical Society, Minneapolis, Minnesota |
| September 14-16 | American Fisheries Society, Augusta, Georgia |

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

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## Books

WORLD POPULATION AND WORLD FOOD SUPPLIES. Sir E. John Russell. George Allen & Unwin Ltd., London, 1954: 515 pp., 45 figs., 44 plates. (Distributed in U. S. A. by the Macmillan Co., New York.)

Sir John Russell, a distinguished agricultural scientist, has an intimate knowledge of most of the important agricultural countries of the world. He is therefore well qualified to write authoritatively about present trends in food production and prospects of increased supplies. Starting with the world's most productive region, Northwest Europe, the author surveys the agricultural pattern in respect to cereals, meat, milk, edible oils, fruits and vegetables in each important country in this and other regions, — Southern and Eastern Europe, Africa, Asia, North and South America and Oceania. Where reliable data are available, he gives an assessment of the nutritional status of the people.

On the whole, the picture is grim but not unhopeful. The world's population of about 2.5 billions is increasing at the rate of at least one percent per annum. Assuming that there is no change in productivity and that the food from one acre suffices to feed one person, then at least 25 million acres of new arable land must be brought into production each year in order to maintain the present low average diet. Alternatively, average productivity must increase by at least one percent per annum. In all continents except North America, food production since the war has barely kept pace with the growth of population, and more than half the people of the world receive an unsatisfactory diet giving less than 2200 calories per day. (The average consumption by Americans and Australians is 3200 calories.)

Attention is drawn to the desperate position in less favoured regions such as Southern Asia and parts of Africa. In India, for instance, even to maintain the present low standards of nutrition—an average of only 1700 calories per head per day--32 million acres of land will need to be added to the cultivated area in the next 10 years, or the output per acre increased by 15 percent. In this, and other, "backward" areas, such increases are possible, but the author concludes that they can be attained only by the slow process of improved education and heavy capital investment in fertilizer factories, agricultural machinery, irrigation works, soil conservation measures and the like. Sir John points out that in regions such as North America and Northwestern Europe where there exists the combination of a well-informed farming community and a strong industrial organization, striking increases in output per acre have been achieved in the last 20 years, and he believes that this upward trend will continue for many years.

While the wider use of existing knowledge could materially increase yields in many areas, there are still many challenging problems for the scientist. Cattle raising in one quarter of Africa is still prevented by the ravages of the tsetse fly; contrary to popular belief, most soils in tropical forests are not fertile and no successful farming system has yet been devised for land reclaimed from these forests; there is, as yet, no satisfactory method of pasture improvement for tropical areas which will even approach the productivity of improved pastures in temperate regions.

Sir John gives little attention to the part that the food technologist can play, and is playing, in conserving and making better use of available supplies. Nevertheless, there is an underlying assumption in the book that suitable methods of processing and preservation are being devised to enable food to be carried over from seasons of glut to seasons of scarcity, and to reduce waste.

While this book will be of greater interest to agriculturalists than to food technologists, nevertheless the latter will find it an invaluable guide if they desire to weigh the responsibilities of their profession on a world, rather than a local, basis. The author has compiled a large mass of vital information from sources not readily accessible in many scientific libraries.

The format of the text and illustrations is attractive and there are comparatively few errors. On page 390, the Canadian consumption of wheat is given as 3½ to 4 million tons a year, but on page 478 as about one million tons. The chief fatty acid in palm oil is stated to be palmitic (p. 286); oleic acid, however, predominates.

J. R. VICKERY
Sydney, Australia

VEGETABLE FATS AND OILS, ACS Monograph No. 123, E. W. Eckey. Reinhold Publishing Corporation (New York) 1954. 836 pp.

Although possessing the same title as its predecessor (ACS Monograph No. 58, 1943, by G. S. Jamison), the present monograph expands and brings the subject matter completely up-to-date. It is an outstanding job. In general, the book is divided into two parts, the first of which consists of seven chapters on such general headings as: Chemical Composition, Physical Properties, Chemical Properties and Reaction of Fats, Biochemical and Nutritional Aspects of Fats, Genesis of Fats and Oils in Plants and Methods. The 15 chapters comprising the second section of this book represent the classification of practically all of the major vegetable fats and oils according to the botanical families that produced them, i.e., Fats of the Gymnosperms, Fats of Some of the Monocotyledons, Fats of the Ranales, etc. This type of a classification facilitates the comparison of different fats belonging to the same plant family, which would be in different categories if placed in the classic groups of drying or non-drying oils.

Extensive and up-to-date references follow each chapter and on controversial subjects, or where discussion had to be limited, the reader is given a selected bibliography. Although there are no specific chapters on processing, milling or utilization of fats and oils, these aspects are discussed in part under the individual fats and oils or are otherwise available from recently published texts.

Written in the authoritative, well-documented manner that we have come to associate with the ACS monograph series, this text is an essential one for the food technologist as well as for other personnel engaged in any phase of processing, producing, or utilizing vegetable fats and oils.

EDWARD E. ANDERSON
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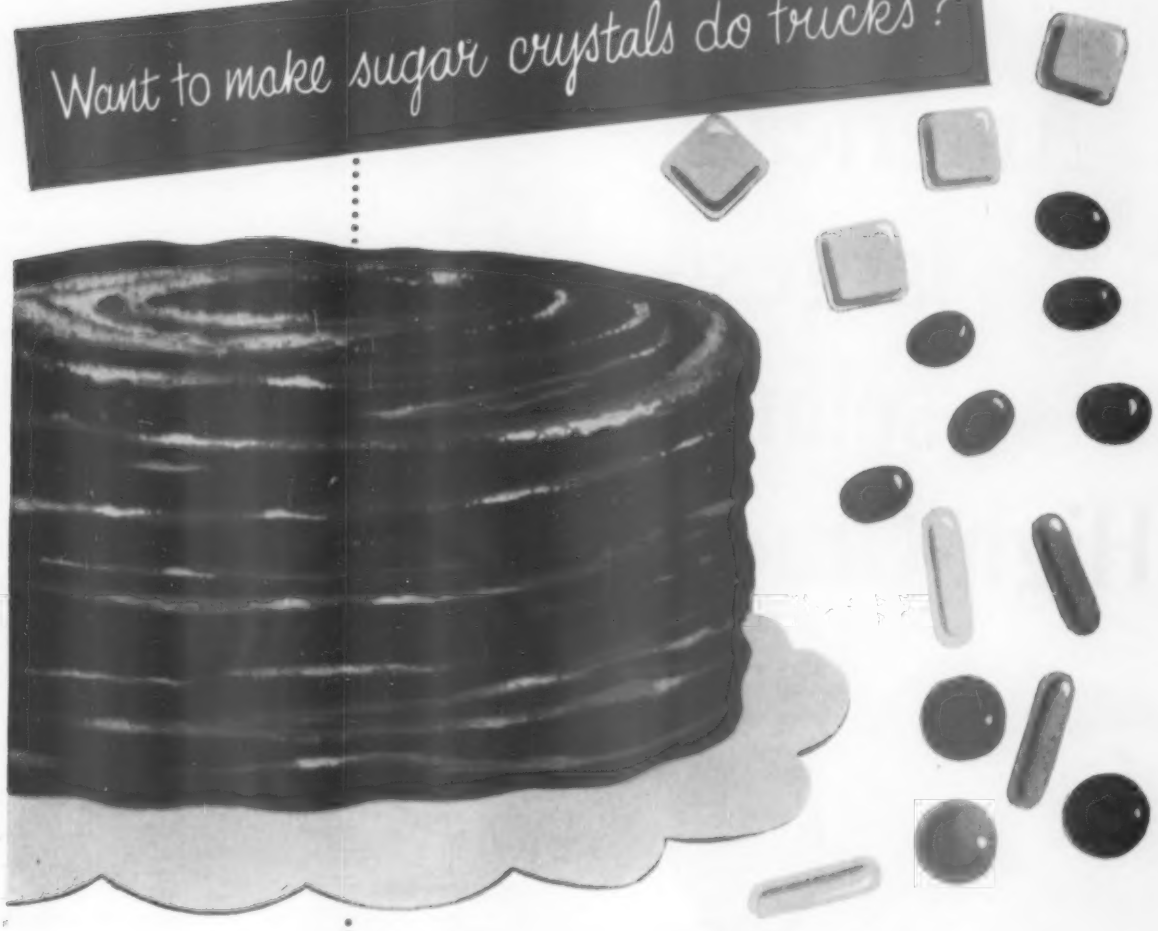

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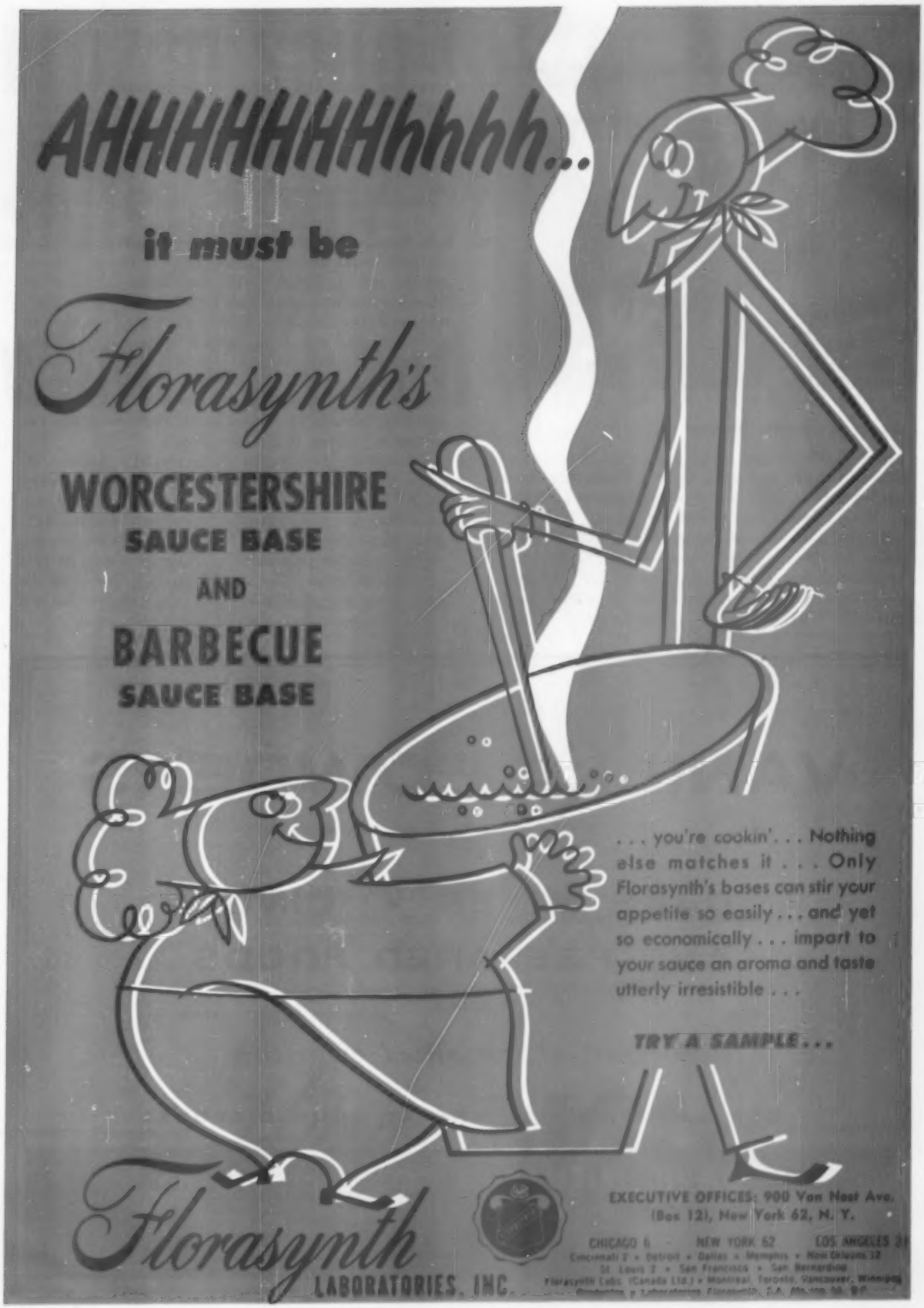
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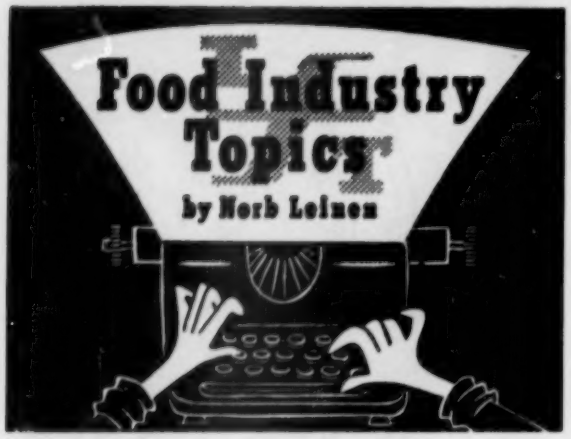


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◆ ◆ ◆

Someone in Communist Poland has found a new way to harass the regime. According to a U. S. Information Agency broadcast, Communist officials are complaining about finding "spikes in their bread." Quoting the official Polish radio, the Agency's Voice of America said in a worldwide broadcast: "Radio Warsaw says there must be an end to 'nails or spikes in our bread and rolls or any other unnecessary objects which have nothing in common with baked goods'." In a lengthy explanation to Polish housewives, these items were given as the reasons for the bad quality of bread in Poland. The Voice added that bread also has become a problem in Czechoslovakia.

Concerning Communist Bulgaria, the Agency reports that new shoes are falling apart, strawberry jam is gathering mould, and other food and raw materials are being wasted. Use of bad raw material supplies, poor processing, and faulty transportation are singled out for particular censure by the country's Communist press. The spoiled food, however, as the same press indignantly pointed out, was destined not

(Continued on page 38 following technical papers)

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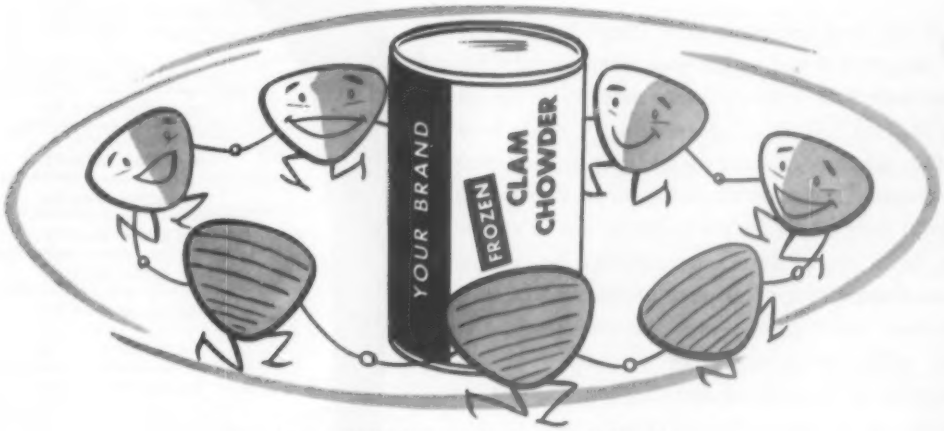


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*Clove-Cassia-Caraway and other spices.*

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# Calcium Chloride as a Non-Enzymic Browning Retardant for Dehydrated White Potatoes[a, b]

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(Manuscript received January 24, 1955)

**An earlier report (17) has shown that treatment of white potatoes with calcium chloride during dehydration processing makes possible the production of potato dice with improved dehydration and rehydration characteristics. The present report shows that the presence of calcium chloride in dehydrated potatoes also renders them less susceptible to non-enzymic browning during storage, and that this greater resistance to browning is related to the calcium content of the product. Calcium used in conjunction with sulfite was shown to be more effective than either of the two used individually. Sensory evaluations have shown that considerable amounts of calcium may be added without sacrifice of acceptance.**

Dehydrated white potatoes, like other dehydrated foodstuffs, are highly susceptible to non-enzymic discoloration (commonly referred to as browning) when stored at warm temperatures. Much effort has been expended in recent years in attempts to increase the resistance of dehydrated food products to this type of deterioration. Some measure of control has been achieved through the use of sulfiting. The objectionable flavor which sulfite imparts to foods, however, restricts the quantities which can be employed. The improvement in keeping quality achievable through the use of lower moisture has been demonstrated often *(3, 5, 8, 10, 12)*. In practice, however, reduction of moisture content to optimum levels by conventional dehydration methods has been limited by the sensitivity of the dehydrated products to heat damage when exposed to the higher dehydration temperatures which would be required to further reduce moisture content. Moreover, the protection attainable through evaporative cooling would be of doubtful value in the final stages of drying. The use of in-package desiccation *(4, 7, 10)* has been proposed as a means for attaining lower moisture levels without heat damage to the product. It has been found in current studies on potato dice at the Western Utilization Research Branch that moisture levels could also be appreciably reduced through extended use of finishing bins.

In earlier work reported by the authors *(17)*, it was demonstrated that dehydration of potato dice to lower moisture levels could be facilitated through the use of thinner potato pieces. It was shown that potatoes of ⅛-inch thickness could be dehydrated to 5% moisture in approximately the same time that was required to dry pieces of $^3/_{16}$-inch thickness to 7% moisture (measured by the 6-hour, vacuum oven method). It was shown further that through the use of calcium chloride for firming, thinner potatoes could be produced which would not slough or become mushy during rehydration and cooking. It was observed in the course of this earlier work directed toward determining the firming effects of calcium chloride, that the calcium-treated potato dice suffered less discoloration when exposed to adverse dehydration conditions, than did the untreated ones. In consequence of this last observation, the current investigation was undertaken to ascertain the extent to which calcium chloride treatment could be employed in helping to control heat damage during dehydration and non-enzymic discoloration during storage at warm temperatures.

## MATERIALS AND METHODS

Potatoes used throughout this study were of the California White Rose variety, which are highly susceptible to browning and not ordinarily used for dehydration, and of the Russet Burbank variety, which are quite resistant to browning and are generally considered to be among the best varieties suitable for dehydration. The raw material was lye peeled, hand trimmed, diced, washed free of surface starch, weighed onto wire trays, and steam blanched for 3 minutes at 212° F. (100° C.). Upon emergence from the blancher, the potatoes were immediately sprayed with cold water, or an aqueous solution of calcium chloride or sodium bisulfite, or mixtures of calcium chloride and sodium bisulfite. Drying was accomplished in a cross-flow cabinet drier with dry bulb temperature of 140° F. (60° C.). Air velocity was 700 f.p.m. ± 10%. In the earlier experiments, the potatoes were cut to ½ x ⅜ x $^3/_{16}$-inch dimensions, loaded in trays at 1½ pounds per square foot, sprayed with ⅜ pound of water or solution per pound of potato and dried for 5 to 5½ hours. In the later experiments, the potatoes were cut to ½ x ½ x ⅛-inch dimensions, loaded on trays at 1 pound per square foot, sprayed with 1 pound of water or solution per pound of potato, and dried for 4 hours.

**Non-enzymic browning.** Non-enzymic browing was determined by a modification of the soluble color method of Hendel, Bailey and Taylor *(2)*. In the exploratory experiments, results of which are shown in Tables 1 and 2, the dehydrated dice were ground through a 2 mm. screen. Twenty grams of the ground material were steeped for one hour in 200 ml. of 2% acetic acid

[a] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, California, June 29, 1954.

[b] This paper reports research, part of which was conducted at the Quartermaster Food and Container Institute for the Armed Forces. This paper has been assigned number 532 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsements of the Department of Defense or the Department of Agriculture.

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in an Erlenmeyer flask of suitable size. Extraction of soluble color was effected by swirling the contents of the flask for one minute at the beginning, middle, and end of the one-hour soaking period. The slurry was then filtered through Whatman No. 12 fluted filter paper. An aliquot of the cloudy filtrate was then clarified by mixing with an equal volume of acetone and again filtering through Whatman No. 3 filter paper. To avoid loss of solvent through volatilization, the funnel was kept covered during the filtration operation. The intensity of the color of the clarified filtrate was measured in the Lumetron photoelectric colorimeter employing a 2-cm. cell and the 420 mμ color filter.

The soluble color data illustrated in Figures 1 and 2 were obtained by essentially the same procedure described above with some minor modifications. In these assays, 5 g. of the ground dice (minus 40-mesh) were extracted with 100 ml. of 2% acetic acid, and soluble color was measured in the Evelyn photoelectric colorimeter using the 420 mμ color filter and the standard Evelyn tube.

**Analytical methods.** Moisture content was measured by grinding the potatoes through a 20-mesh screen and drying the ground material for 40 hours in a vacuum oven at 158° F. (70° C.). Sulfite was measured by the procedure specified in the military specification for white potatoes *(13)*. The method of Ingols and Murray *(9)* was employed in the determination of calcium. Methods of the Association of Official Agricultural Chemists *(1)* were employed in measuring pH and reducing sugar.

**Sensory tests.** For sensory appraisals of the potato dice, the dehydrated products were rehydrated and cooked by immersing one part of dice in 7 parts of cool water, heating slowly, bringing to a boil in 30 minutes, and then simmering until tender. The cooked dice were flavored only with margarine and salt, and served to a panel of observers who were instructed to evaluate the products in terms of appearance, texture and flavor, on a 9-point quality rating scale ranging from *extremely poor* at the lower end of the scale to *excellent* at the upper end of the scale.

## RESULTS AND DISCUSSION

**Exploratory experiments.** To check the validity of an earlier observation that calcium treated potato dice discolored less than untreated ones under adverse dehydration conditions, two experiments were carried out under conditions known to be conducive to rapid browning; namely, dehydration at high temperatures and storage at elevated temperatures. Two varieties of tubers were employed in these experiments—White Rose and Russet Burbank. These were trimmed, peeled, diced, and steam blanched for 3 minutes at 212° F. (100° C.). Immediately following blanching and just prior to dehydration, separate batches of dice from each variety were subjected to one of three spray treatments; these were: (a) water, (b) 0.5% $CaCl_2 \cdot 2H_2O$, and (c) 1.0% $CaCl_2 \cdot H_2O$. In the first of these experiments, the dice were dehydrated at 170° F. (78° C.). Ordinarily, temperatures of 140° F. (60° C.) were employed in drying our potatoes; the higher temperature was used here, however, in order to induce heat damage so that the effects of the calcium treatment might be more quickly observed. Portions of each sample of White Rose potatoes were removed from the drier after 3½ hours of dehydration and again after 6 hours. Russet Burbanks were dried for 3½ and 7 hours. The extent of heat damage in each of the products was estimated by dilute acetic acid extraction of soluble color from finely ground material, clarification of the extract with acetone, and measurement of the color in the clarified extract.

The reaction of the various test samples to the excessively high temperatures used in drying them is shown in Table 1. The browning retardant action of calcium chloride was especially evident in the White Rose potatoes, which are known to be highly susceptible to browning. In the earlier stages of dehydration where the potatoes were to some extent protected against heat damage by evaporative cooling, little browning occurred even in the untreated material; hence, the protective effects of calcium were only minor. In the later stages of dehydration where the product was fairly dry and the danger of heat damage was much greater, the browning retardant action of calcium chloride was quite evident and directly related to the amount of calcium used. With the Russet Burbank potatoes, which were much more resistant to browning than those of the White Rose variety, no significant browning occurred in any of the samples during the earlier stages of dehydration. As drying was continued and browning became more apparent, only the higher level of calcium chloride treatment proved to be of any help.

**TABLE 1**

**Influence of calcium chloride treatment in retarding heat damage during high temperature dehydration [1]**

| Potato variety | Spray solution | Absorbency of extracts from potatoes dehydrated for | | |
|---|---|---|---|---|
| | | 3½ hours | 6 hours | 7 hours |
| White Rose | Water | .061 | .153 | ..... |
| | 0.5% $CaCl_2 \cdot 2H_2O$ | .059 | .116 | ..... |
| | 1.0% $CaCl_2 \cdot 2H_2O$ | .038 | .074 | ..... |
| Russet Burbank | Water | .024 | ..... | .048 |
| | 0.5% $CaCl_2 \cdot 2H_2O$ | .026 | ..... | .048 |
| | 1.0% $CaCl_2 \cdot 2H_2O$ | .020 | ..... | .036 |

[1] Dry bulb temperature—170° F.; wet bulb temperature—90° F.

In the second of these exploratory experiments, potato dice of the same two varieties, treated with water, 0.5% $CaCl_2 \cdot 2H_2O$, and 1.0% $CaCl_2 \cdot 2H_2O$, were dried for 5 hours at 140° F. (60° C.), adjusted to approximately 7% moisture (measured by the 6- hour, vacuum oven method), and stored in hermetically sealed containers at 131° F. (55° C.). Non-enzymic browning was taken as the increase in soluble color (absorbency) after 3 and 5 days of storage at this temperature. The results (Table 2) again demonstrate the effectiveness of calcium chloride in increasing the resistance of potato dice to non-enzymic discoloration. Under the exceptionally high storage temperatures employed here (131° F., 55° C.), the untreated potatoes within a given variety discolored appreciably more than any of the treated potatoes of the same variety. The retarding action was again directly related to the strength of the calcium chloride solution applied, with the best results having been obtained with the product containing the most calcium. The greater susceptibility of the White Rose potatoes to browning is here again revealed.

**TABLE 2**

**Influence of calcium chloride treatment in retarding non-enzymic browning during accelerated storage at 131° F. (55° C.)**

| Potato variety | Spray solution | Absorbency of extracts of dehydrated potatoes [1] | | | Browning (increase in absorbency) | |
|---|---|---|---|---|---|---|
| | | Before storage | Stored 3 days | Stored 5 days | After 3 days | After 5 days |
| White Rose | Water | .067 | .181 | .299 | .114 | .232 |
| | .5% $CaCl_2 \cdot 2H_2O$ | .073 | .147 | .241 | .074 | .168 |
| | 1% $CaCl_2 \cdot 2H_2O$ | .064 | .129 | .218 | .065 | .154 |
| Russet Burbank | Water | .039 | .092 | .204 | .053 | .165 |
| | .5% $CaCl_2 \cdot 2H_2O$ | .039 | .073 | .145 | .034 | .106 |
| | 1% $CaCl_2 \cdot 2H_2O$ | .038 | .060 | .132 | .022 | .094 |

[1] Dehydrated at 140° F. dry bulb temperature and adjusted to approximately 7% moisture (6 hour-vacuum oven method) prior to storage.

**Influence of graded levels of calcium chloride.** In consequence of the favorable results obtained in the exploratory experiments, the investigation was extended in an effort to ascertain the effects of varying levels of calcium, not only on non-enzymic browning, but also on the cooking and sensory characteristics of dehydrated potato dice. A series of samples was prepared from a single lot of Russet Burbank potatoes, the variety most commonly used in production of dice. The processing operations for each of the samples were identical except for the strength of the post blanching spray solutions used in applying the calcium chloride. After dehydration for 5 to 5½ hours, the dice were carefully adjusted to approximately the same moisture level, packaged in hermetically sealed cans and stored at 70°, 100° and 117° F. (21°, 38° and 47° C.). Portions of each sample were also set aside for evaluation of reconstitution and cooking characteristics and for sensory appraisal of the cooked products.

For adjustment to uniform moisture levels, those samples of potato dice which were slightly above the desired level were

**TABLE 3**

**Analytical data on dehydrated potato dice treated with graded quantities of calcium chloride**

| Post blanching spray solution | Calcium, percent | Moisture, percent | pH | Reducing sugar,[1] percent |
|---|---|---|---|---|
| Water | 0.02[2] | 8.0 | 5.8 | 0.99 |
| 0.5% $CaCl_2 \cdot 2H_2O$ | 0.12 | 8.0 | 5.6 | 1.25 |
| 1.0% $CaCl_2 \cdot 2H_2O$ | 0.20 | 8.0 | 5.6 | 0.77 |
| 2.0% $CaCl_2 \cdot 2H_2O$ | 0.39 | 8.2 | 5.4 | 0.88 |
| 4.0% $CaCl_2 \cdot 2H_2O$ | 0.84 | 8.1 | 5.2 | 1.33 |

[1] As dextrose.
[2] Control sample, untreated.

dried in the vacuum shelf drier with a shelf temperature of 100° F. (38° C.) until the desired amount of moisture had been removed. Those samples which were somewhat low in moisture were sprayed with quantities of water calculated to bring the products to the desired moisture level. The dice were then tumbled immediately to assist in equilibration of moisture. The tumbling operation was repeated for 2-minute intervals every day for about a week.

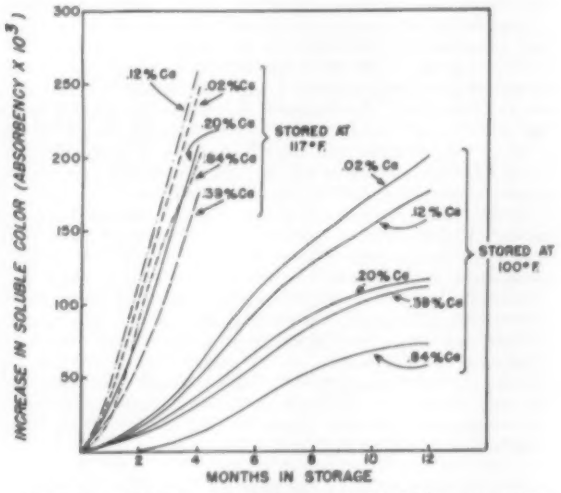


**Figure 1. Influence of varying levels of calcium on susceptibility of dehydrated white potato dice to non-enzymic browning during storage at 100° and 117° F.**

It may be seen from the data in Table 3 that the samples were fairly uniform with respect to moisture content, ranging from 8.0 to 8.2%. It may be noted also that the amounts of calcium taken up by the potato dice are closely related to the strength of the solution with which they were sprayed. The marked variations in reducing sugar level from sample to sample was something which we were unable to control during preparation of the experimental materials. Although the differences in pH are not very large, they are directly related to the strength of the calcium chloride solutions with which the various samples were treated.

In Figure 1 is illustrated the reaction of the different products to storage temperatures of 100° and 117° F. (38° and 47° C.). No data are furnished on the performance of the products at 70° F. (21° C.) since no visible or measurable browning occurred at that temperature during the one year storage period covered by this report. At 100° F. (38° C.), the rate of browning was found to be inversely related to calcium content, with browning developing fastest in the untreated control and diminishing steadily as the content of calcium was increased. As might be anticipated, the browning rate at 117° F. (47° C.) was much greater than at 100° F. (38° C.). Contrary to expectations, however, the relationship between browning retardation and calcium content observed at 100° F. (38° C.) did not hold at the higher temperature. An explanation may possible lie in the marked variation in reducing sugar content from sample to sample. It is generally recognized that the development of browning in foodstuffs may result from a number of different reactions. It is quite likely that the different reactions may have different temperature coefficients and that reducing sugar may be a more important factor in some of these reactions than in others, especially at the higher temperatures. It is further probable that calcium, or any other inhibitor, may be effective against one reaction and not against another. It appears to be more than just coincidence that at 117° F. (47° C.) the two samples which deviated from the pattern noted at 100° F. (38° C.) contained appreciably larger quantities of reducing sugar than did the other samples. Reducing sugar data are shown in Table 3. For example, the 0.12% calcium product which performed better than the untreated control at 100° F. (38° C.), but not as well as the control at 117° F. (47° C.), contained 1.25% reducing sugar, whereas the reducing sugar content of the control was only 0.99%. The product containing the highest level of calcium, 0.84%, performed best at 100° F. (38° C.), but only as well as the 0.20% calcium product at the higher temperature. The reducing sugar levels in these materials, however, were quite different, being 1.33% in the high calcium dice and only 0.77% in the other. Where reducing sugar levels were approximately equal, as in the case of the control and the product containing 0.39% calcium, the presence of calcium was an important factor in reducing browning, even at the higher temperature.

**Calcium and sulfite as browning retardants.** Consideration was given next to the likelihood that in the presence of sulfite, the effectiveness of calcium might be even more impressive. Consideration was given also to the possibility of a contrasting effect, owing to the relative insolubility of calcium sulfite which could possibly obviate the individual effects of calcium and sulfite. Accordingly, additional experiments were set up to ascertain the comparative effects of calcium, sulfite, and of the two used in combination. Dice were prepared from potatoes of the White Rose and Russet Burbank varieties, employing the same processing conditions previously described except for the composition of the post blanching spray solutions. These consisted of aqueous solutions of calcium alone, sulfite alone, and of the two in combination. After dehydration, all samples of potato dice from a given variety were carefully adjusted to similar moisture levels, ranging from 8.3 to 8.5% in the White Rose, and from 8.5 to 8.7% in the Russet Burbanks; they were then packaged in hermetically sealed containers and placed in storage at 100° F. (38° C.). Calcium, sulfite, reducing sugar and pH data are shown in Table 4. The small amount of calcium present in the control dice and those which had been treated with sulfite alone, represents the natural calcium content of potatoes.

Figure 2 illustrates how the various treatments affected the development of browning during 3 and 6 months of storage. In the case of the White Rose potatoes, which brown rather easily, considerable discoloration occurred within the first 3 months in the control sample, in which plain tap water was used for the post blanching spray. Presence of sulfite alone in these particular samples appeared to be of only minor benefit during the earlier stages of storage and of no value at all in the later stages. Use of calcium alone gave far more protection to the White Rose dice than did the use of sulfite alone. The best results by far were attained through the use of the 2 reagents in combination. All of the calcium treated White Rose samples, with and without sulfite, discolored less during 6 months of storage than did the control material during only 3 months of storage.

With the Russet Burbanks, significant browning occurred only in the untreated control during the first 3 months. Only traces of browning, as indicated by the small increase in the amount of soluble color, were present in any of the treated samples. Application of sulfite alone reduced browning during the 6 months period to about 30% of that in the control material, with slightly more discoloration developing in the lower sulfite product. Treatment with calcium alone reduced browning to about 25% of that in the control. In the case of the dice containing 0.40% calcium and 290 p.p.m. sulfite, browning was reduced to 17% of that in the control, while in those containing 0.43% calcium and 330 p.p.m. sulfite, the extent of browning was only 8% of that of the control. The results of sensory tests

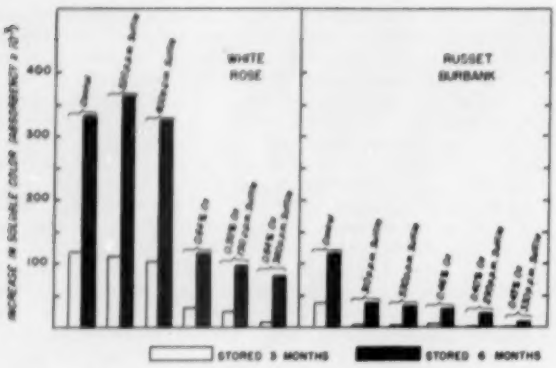


**Figure 2. Calcium, sulfite, and combinations of calcium and sulfite as retardants of non-enzymic browning in dehydrated white potato dice stored at 100° F.**

shown in Table 6, together with those from unpublished studies relating graded levels of calcium to the cooking characteristics of dice from different varieties of potatoes, suggest that calcium in the range of 0.2 to 0.4% would be optimum and that as much as 0.6% could be tolerated.

Several years ago reports were made by Patton *(14)* and Pyke, *et al. (15, 16)* on the use of calcium chloride blanching as a means for increasing the resistance of potato dice and chips to non-enzymic browning. The distinction between the method of Patton and Pyke, *et al.* and that reported here should be recognized. In their work, potato dice were blanched by immersion in a near boiling, weak solution of calcium chloride. The increased resistance to browning of their products has been attributed to the efficiency of the hot calcium chloride solution in extracting from the potatoes those components which are responsible for non-enzymic browning, notably reducing sugar and amino compounds. For best results, they found it necessary to use very small pieces of potatoes and rather lengthly extraction periods. Needless to say, this type of treatment must undoubtedly have removed much of the flavor and nutritional components of the potatoes.

**TABLE 4**

**Analytical data on dehydrated potato dice treated with calcium chloride and sulfite, singly and in combination**

| Potato variety | Sample number | Calcium percent[1] | Sulfite, p.p.m. | Moisture percent | pH | Reducing sugar, percent[2] |
|---|---|---|---|---|---|---|
| White Rose | FV-106[3] | 0.03 | None | 8.3 | 6.0 | 2.3 |
| | FV-107 | 0.03 | 220 | 8.3 | 6.0 | 2.6 |
| | FV-108 | 0.03 | 400 | 8.3 | 5.9 | 2.4 |
| | FV-111 | 0.64 | None | 8.5 | 5.4 | 2.0 |
| | FV-109 | 0.50 | 150 | 8.3 | 5.5 | 2.3 |
| | FV-110 | 0.64 | 380 | 8.4 | 5.5 | 2.6 |
| Russet Burbank | FV-112 | 0.03 | None | 8.7 | 5.7 | 1.2 |
| | FV-113 | 0.03 | 310 | 8.7 | 5.8 | 1.4 |
| | FV-114 | 0.03 | 530 | 8.6 | 5.8 | 1.4 |
| | FV-117 | 0.46 | None | 8.5 | 5.3 | 1.4 |
| | FV-115 | 0.40 | 290 | 8.7 | 5.4 | 1.5 |
| | FV-116 | 0.43 | 330 | 8.6 | 5.4 | 1.5 |

[1] Naturally present calcium content is 0.03%.
[2] As dextrose.
[3] Control samples; neither calcium nor sulfite added.

In the study reported here, no attempt was made to remove the sugars and amino compounds. The potatoes were blanched in atmospheric steam, and upon emergence from the blancher were merely sprayed with a cold aqueous solution. This could have done no more than wash away a small amount of surface material. Consequently, it is not considered likely, and this is confirmed by the data shown in Tables 3 and 4, that extraction of browning constituents could possibly have been a factor in the increased resistance to non-enzymic browning of our calcium treated products.

A definite explanation of the mechanism whereby calcium serves to retard non-enzymic browning in dehydrated potatoes cannot be offered at this time. It has been observed that a slight depression in the pH of the dehydrated material accompanies the addition of calcium chloride. Although the small change in pH might conceivably have contributed in a small way to the control of browning, it is highly doubtful that it could have been responsible for an inhibitory action of the magnitude observed in these experiments. The authors believe that calcium may be acting in some manner to block the amino group, whereby the latter is restrained from entering into the browning reaction. In a publication by Henn *(6)*, it was reported that calcium is capable of forming chelate compounds with organic substances having an alpha amino carboxylic acid structure. Under these circumstances, it would be reasonable to expect that calcium treatment may be applicable to control of non-enzymic browning in many products where this particular type of browning reaction may be a problem. Such studies are now in progress in the laboratories of the authors.

From the data presented here, together with other information acquired on the subject, it appears that increasingly greater protection against nonenzymic browning could be achieved through the use of larger and larger quantities of calcium. It was recognized, nevertheless, that in actual practice the use of calcium would necessarily be limited by its effects on the utility and acceptance characteristics of the product. Excessive quantities of calcium could result in products so tough that inordinately long cooking periods would be required for achieving desired tenderness. Furthermore, beyond certain concentrations calcium chloride would impart an undesirable flavor to the product. Experiments were set up, therefore, to determine what effect varying amounts of calcium chloride would have on the quality characteristics of dehydrated potato dice.

**Utility tests.** Ordinarily, potato dice are reconstituted and cooked by addition of one part of dice to 7 parts of water, heating slowly so that the mixture is brought to a boil in about 30 minutes, and simmering for an additional 10 minutes. Past experience has proven this 10-minute simmering period to be rather critical, inasmuch as cooking the potatoes only slightly beyond where they become tender often resulted in undesirable sloughing and mushiness. In an earlier report *(17)* it was pointed out that firming by even small amounts of calcium made the dice much more resistant to physical deterioration, hence, better able to withstand longer cooking periods and rougher handling during preparation.

**TABLE 5**

**Effect of calcium content on cooking characteristics of dehydrated white potato dice**

| Calcium content, percent | Rehydration ratio and degree of doneness after simmering for[1] | | | |
|---|---|---|---|---|
| | 10 minutes | 20 minutes | 30 minutes | 35 minutes |
| 0.02[2] | 3.94:1 (done) | 4.66:1 (mushy) | ..... | ..... |
| 0.12 | 4.00:1 (hard) | 4.20:1 (done) | ..... | ..... |
| 0.20 | 3.87:1 (hard) | 4.13:1 (sl. hard) | 4.44:1 (done) | ..... |
| 0.39 | 3.66:1 (hard) | 4.33:1 (hard) | 4.34:1 (sl. hard) | ..... |
| 0.84 | ..... | 4.20:1 (hard) | ..... | 4.53:1 (firm) |

[1] One part of potato dice was added to seven parts of water and heated slowly, bringing to a boil in 30 minutes and then simmering for indicated length of time.
[2] Untreated sample.

In the current investigation, potato dice of varying calcium content were reconstituted and cooked by bringing them to a boil in 30 minutes, and then allowing them to simmer from 10 to 35 minutes depending on calcium level. The extent of rehydration and degree of doneness were measured at intervals during the simmering operation. The results of these experiments are revealed in Table 5. The untreated potatoes were completely cooked by the end of the 10-minute simmering period. Extending the simmering time to 20 minutes results in an extremely mushy and watery mass. From these data it is apparent that the amount of simmering required for calcium treated potatoes was directly related to the calcium content. It has been found in some recent work, as yet unpublished, that calcium treated potato dice could be cooked well beyond the

point where they became tender without sloughing seriously. Thus, it is clear that while the calcium treated materials require a longer simmering period (depending on calcium content), they are better able to withstand actual cooking abuse—a highly important factor in light of the conditions often existing in field meal preparation. The possibility remains also, that because of the increased resistance of the calcium treated product to sloughing, modifications can be made in the preparational procedures whereby the time required for bringing to a boil may be substantially reduced from the 30-minute period presently employed.

**Sensory tests.** For sensory appraisals of this series of potato dice, all products were brought to a boil in 30 minutes and then simmered until, in the judgment of the home economist conducting the tests, they had been cooked to approximately the same degree of tenderness. The simmering period employed in preparation of each of the samples is indicated in Table 6. The cooked dice, flavored only with margarine and salt, were served to a panel of judges who were instructed to evaluate the products on the basis of appearance, texture, and flavor. It is apparent from the scores (Table 6) that the appearance of the cooked product was increasingly improved by increasing amounts of calcium. The significantly lower appearance and texture scores of the control material may be explained by complaints of mushiness made by a number of judges; this, despite the fact that this sample was cooked for a considerably lesser period than any of the other samples. No satisfactory explanation for the lower texture score of the 0.39% calcium product was obtainable from the comments and criticisms of the panel judging the products. Inasmuch as the texture scores of the samples containing both less and more calcium were significantly higher, the texture score of the 0.39% calcium potatoes must be considered an anomaly. This conclusion is borne out by results obtained in tests with other potatoes conducted at a later date; in these tests the texture score of potato dice containing similar amounts of calcium compared well with those of products containing more or less calcium. The lower flavor score of the high calcium product may be attributed to some undesirable flavor which probably became detectable through use of this large quantity of calcium chloride. This correlated well with comments received from panel members. It may be reasoned from these data that moderate quantities of calcium chloride would not only be tolerable but might even favor the acceptance of the product. A study is now in progress which it is expected will provide much information on the effects of graded quantities of calcium chloride on the utility and acceptance characteristics of different varieties of potatoes.

**TABLE 6**

**Effect of calcium concentration on quality factors of dehydrated potatoes**

| Calcium content, percent | Simmering time | Total cooking time[1] | Quality rating score[2] | | |
|---|---|---|---|---|---|
| | | | Texture | Appearance | Flavor |
| 0.02[3] | 11 minutes | 41 minutes | 5.71 | 5.65 | 5.76 |
| 0.12 | 21 minutes | 51 minutes | 6.00 | 6.06 | 5.88 |
| 0.20 | 26 minutes | 56 minutes | 6.12 | 6.12 | 6.05 |
| 0.39 | 36 minutes | 66 minutes | 5.53 | 6.29 | 5.94 |
| 0.84 | 41 minutes | 71 minutes | 5.94 | 6.41 | 5.18 |

[1] Includes 30 minutes required for bringing to a boil prior to simmering.
[2] Based on 17 judgments; a score of 3 denotes poor, 5 denotes fair, 7 denotes good, and 9 denotes excellent.
[3] Untreated sample.

Of the various recipe items in which potato dice may be used, the one selected for these sensory tests was deemed to be the most critical for ascertaining the influence of additives—in this case, calcium chloride—on the flavor quality of the product. Previous experience has demonstrated that the acceptance of this particular recipe item, that is, potatoes flavored only with salt and margarine (or butter), is almost entirely dependent on the flavor of the potatoes. In other recipe items such as potato salad or hashed browned potatoes, acceptance is largely influenced by the highly flavored condiments which are added, or by the flavors which develop during frying. There is little question that dice that are acceptable when seasoned only with margarine and salt will prove acceptable as potato salad, hashed browned potatoes, or other recipe items.

## SUMMARY

It has been shown that calcium chloride treatment of potatoes for dehydration offers a new means for helping to control heat damage during drying, and non-enzymic browning during storage at warm temperatures. Moreover, moderately large quantities of calcium may be employed without impairment of the acceptance of the product. Calcium used in conjunction with sulfite was found to be more effective than either of the two used individually.

### Acknowledgment

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# The Effect of Variations in Moisture Content on the Storage Deterioration Rate of Cake Mixes[a]

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**The effect of moisture content on the storage life of chemically leavened cake mixes (white, yellow, gingerbread, devil's food) is studied. Physical properties of cakes prepared from stored mixes are shown to undergo change as a result of premature reaction of leavening ingredients. An increase in free fatty acids is noted in stored mixes of moderate to high moisture contents. Products formulated with flour of 7.4% moisture content or less were generally resistant to deleterious changes during storage.**

The great increase in popularity of prepared cake mixes within the last decade has made the storage stability of these products a matter of prime importance to a large segment of the cereal industry. The first mixes placed on the market had a very short shelf life and frequently became unusable within a few weeks or months after manufacture. It is known that one of the chief factors affecting the stability of these mixes is a loss of leavening power due to a premature reaction of the sodium bicarbonate with the acidic components of the mix *(6)*. The rate of this reaction is greatly affected by the moisture content of the other mix ingredients, especially the flour *(7)*. Flour moisture is also known to affect the rate at which free fatty acids develop, and relatively large quantities of free fatty acids are believed to affect the baking quality of flour *(3)*.

Considerable work has been done on the relationship between moisture content of flour and the rate at which its suitability as a bread ingredient decreases during storage. Cuendet *et al., (2)* found that the stability of various grades of wheat flour stored in sealed containers at 37.8° C. decreased with decreasing refinement and with increasing moisture content. Greer, Jones, and Moran *(4)* found that flour of 13-14% moisture content stored up to 10 years at ordinary temperatures retained satisfactory baking quality when the ash content was below 0.6%, the protein content was below 11%, and the flour was packed in non-gas-tight containers. The conclusions reached by these workers with bread flour are no doubt applicable, in some degree, to cake mixes, but there are special problems connected with the latter product which have heretofore remained unexplored.

These considerations suggested that a definitive study of the effect of moisture content on the storage life of cake mixes would be of value in determining specification requirements. To this end, four varieties of cake mix, each utilizing flour at seven different moisture contents, were stored at 72° F. and 100° F. Samples were withdrawn from storage and baked and chemically tested at predetermined intervals. The cakes were judged for quality, and their specific volumes and pH's were determined.

## MATERIALS AND METHODS

The varieties of cake mix studied were white, yellow, gingerbread, and devil's food—probably the most popular of the varieties sold in this country. Formulations of the mixes are listed in Table 1.

**TABLE 1**

**Formulations of experimental cake mixes**

| | White cake | Yellow cake | Devil's Food cake | Gingerbread cake |
|---|---|---|---|---|
| | % | % | % | % |
| Flour [1] | 36.7 | 36.0 | 29.6 | 33.0 |
| Sugar | 43.0 | 42.1 | 43.0 | 37.3 |
| Shortening | 12.4 | 12.3 | 12.4 | 12.4 |
| Baking Powder | 2.0 | 2.0 | 0.6 | 2.0 |
| Nonfat Milk Solids | 3.0 | 3.0 | 3.0 | 3.0 |
| Dry Egg Albumen | 2.0 | .... | .... | .... |
| Dry Whole Egg | .... | 3.6 | 3.6 | 3.6 |
| Sodium Bicarbonate | .... | .... | 0.9 | .... |
| Salt | 1.0 | 1.0 | 0.9 | 0.7 |
| Cocoa | .... | .... | 6.0 | .... |
| Molasses Solids | .... | .... | .... | 6.9 |
| Spice Mixture | .... | .... | .... | 1.1 |

[1] 14% moisture basis.

Flavoring ingredients which are ordinarily present in small quantities in commercial cake mixes (e.g. vanilla and lemon oil) were not added because it was felt that their presence would not alter the course of staling and yet their odor and flavor might obscure the organoleptic changes taking place in the mix. On the other hand, flavoring ingredients such as molasses solids and cocoa were added because they make a significant contribution to the baking properties as shown by the physical and chemical characteristics of the cake. For example, cocoa can appreciably alter the pH of the product, and molasses solids contain considerable quantities of elements known to accelerate fat oxidation.

A high stability hydrogenated vegetable oil shortening containing 3.2% monoglycerides (as mono-oleate) was used in these mixes. The cocoa was a natural type with a fat content of 25%, a pH of 5.72 and a moisture content of 2.7%. The molasses solids had a moisture content of 1.63%, an ash of 8.72%, reducing sugars (as glucose) 11.9% and sucrose 51.9% ("as is" basis).[d] Chemical characteristics of the flours were: ash—0.33%, protein—7.53%, fat—1.04%, and pH—4.9, all on a 14% moisture basis. In Table 2 are listed other pertinent analytical values for the flours. The differences are due to

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[d] Unless otherwise noted, tests were performed according to the appropriate procedure in AOAC Methods *(1)*.

changes which occurred during the storage period of about 19 months subsequent to drying and prior to incorporation in the mixes.

**TABLE 2**
**Chemical characteristics of dehydrated and control flour**

| Final flour moisture content | Maximum flour temperature during dehydration | Peroxide value[1] | Carbonyl value[2] | Free fat acidity[3] | Lipid fluorescence[4] |
|---|---|---|---|---|---|
| % | ° F. | | | | |
| 13.7 | ..... | NF | 35 | 21.4 | 127 |
| 8.8 | 108 | NF | 27 | 11.6 | 142 |
| 7.4 | 125 | NF | 24 | 10.1 | 147 |
| 5.3 | 140 | NF | 30 | 8.5 | 173 |
| 4.7 | 156 | 8 | 37 | 8.0 | 164 |
| 3.2 | 183 | 292 | 221 | 8.0 | 216 |
| 2.6 | 159 | 209 | 348 | 4.4 | 240 |

[1] As milliequivalents of peroxide per kilogram of fat.
[2] As micromoles per gram of fat.
[3] As percent oleic acid in the fat.
[4] As microgram equivalents of quinine sulfate per gram of fat.

The egg products used had been desugared by an enzymic process. The dry albumen contained 6.95% moisture and 79.1% protein. The dry whole eggs contained 4.95% moisture, 41.2% fat, 44.3% protein, and 0.48% lipoid phosphoric acid. Less than 0.1% of reducing sugars was found in these egg products.

High-heat non-fat milk solids were used in the mixes. This product contained 2.13% moisture, 1.03% fat, 1.36% titratable acidity ( as lactic) and 0.5 mg. iron per 100 g.

Mixes were prepared by beating together all ingredients except the flour and cocoa in the stainless steel bowl of an electric mixer until a "creamed" mass was formed, then adding the remaining ingredients and mixing until the product was homogeneous. Five-hundred gram portions of this mixture were filled into No. 2½ cans which were then sealed immediately. The cans were stored in rooms held at 72° ± 1° F. and 100° ± 1° F. Moisture contents of the mixes are given in Table 3.

Samples for baking tests were withdrawn from 72° F. storage at 6, 12, and 18 months, and from 100° F. storage at 1, 2, 4, 6, 8, 12, and 18 months.

Cakes were prepared according to a standardized baking procedure. An amount of water corresponding to 50% of a standard formula mix and corrected for the difference in flour moisture content so that each batter contained the same ratio of dry matter to moisture, was added in 2 equal portions to the mix while it was being agitated at low speed in a Hobart mixer. Each time, after adding the water, the batter was agitated for 2 minutes at medium speed. After mixing, the specific gravity was determined.

**TABLE 3**
**Original moisture content of experimental mixes**

| Flour | White cake mix | Yellow cake mix | Gingerbread cake mix | Devil's Food cake mix |
|---|---|---|---|---|
| Moisture content | Moisture content | Moisture content | Moisture content | Moisture content |
| % | % | % | % | % |
| 13.7 | 5.1 | 5.0 | 4.8 | 4.3 |
| 8.8 | 3.2 | 3.4 | 3.3 | 2.9 |
| 7.4 | 2.9 | 2.8 | 2.9 | 2.5 |
| 5.3 | 2.2 | 2.0 | 2.2 | 2.0 |
| 4.7 | 1.9 | 1.8 | 1.9 | 1.7 |
| 3.2 | 1.3 | 1.3 | 1.6 | 1.2 |
| 2.6 | 1.2 | 1.1 | 1.3 | 1.1 |

The batter was poured into circular 8-inch aluminum cake pans containing a paper disc on the bottom. The white and gingerbread cakes were scaled at 400 g., the yellow at 375 g. and the devil's food at 350 g. Cakes were baked at about 350° F. Because of difficulty in maintaining an exact temperature while baking a large number of cakes and because of other variables, the cakes were left in the oven until the technologist judged them to be satisfactorily baked. A series of replicate bakes demonstrated that this is a reliable timing method when used by an experienced technologist.

After baking, cakes were allowed to cool, removed from the pan, and prepared for photography. After photographing under uniform conditions, the cakes were weighed and the volume determined by rape-seed displacement. Cakes were sliced vertically and horizontally and scored for texture, grain, crumb color, and odor. The pH was determined by mixing 200 ml. of distilled water with 100 g. of crumb, letting the paste stand for 20 minutes and then testing it on an electronic pH meter.

Chemical analyses of the mix samples stored at 72° and 100° F. were made at 0, 6, 12, and 18 months. Percentage of carbon dioxide in the can headspace was determined as an indication of the extent to which premature reaction of the leavening ingredients had occurred. Moisture contents of the mixes were determined by the vacuum oven method. Fat was extracted from the mixes, and the free fat acidity, peroxide value, and carbonyl value *(5)* were determined. Saline fluorescence was determined by the method of Pearce and Thistle *(8)* modified as to the sample size and method of standardization, and lipid fluorescence was similarly determined using a chloroform extract. The pH was determined on a mix slurry by the electrometric method.

## RESULTS AND DISCUSSION

Specific gravities of the batters showed no discernible trend and so are not reproduced here. Slight variations in mixing procedure appeared to have more effect on the specific gravities than did storage time or temperature. Specific volumes of representative test cakes are shown in Table 4. These figures indicate that mixes made with flour of 13.7% moisture content deteriorated greatly during storage for 18 months at 100° F. and finally became wholly unacceptable. All white and yellow mixes made with drier flour tolerated storage for one year at 72° or 100° F. reasonably well, producing cakes which were acceptable (from a volume standpoint) at the end of that time. On the other hand, the gingerbread cake mixes and the devil's food cake mixes made with flour of 8.8% moisture had deteriorated considerably at the end of a year's storage at the

**TABLE 4**
**Specific volumes of cakes made from stored mixes**

| Mix variety | Moisture content | Storage temperatures | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 72° F. | | | | 100° F. | | | | | | |
| | | Storage time (months) | | | | Storage time (months) | | | | | | |
| | | 0 | 6 | 12 | 18 | 1 | 2 | 4 | 6 | 8 | 12 | 18 |
| | % | | | | | | | | | | | |
| White | 5.1 | 3.4 | 3.2 | 3.0 | 2.9 | 3.0 | 2.9 | 2.6 | 2.4 | 2.0 | 1.8 | ... |
| White | 3.2 | 3.3 | 3.2 | 3.2 | 3.1 | 3.1 | 3.0 | 3.0 | 3.2 | 3.1 | 3.2 | 2.8 |
| White | 2.9 | 3.1 | 3.1 | 2.8 | 3.0 | 2.8 | 2.8 | 3.1 | 3.1 | 2.9 | 2.9 | 2.7 |
| White | 1.2 | 3.4 | 3.0 | 3.0 | 2.9 | 3.1 | 3.0 | 3.0 | 2.9 | 2.8 | 2.5 | 2.6 |
| Devil's Food | 4.3 | 2.9 | 2.5 | 1.6 | 1.9 | 2.5 | 2.3 | 2.1 | 2.0 | 1.8 | ... | ... |
| Devil's Food | 2.9 | 3.0 | 2.7 | 2.5 | 2.4 | 3.0 | 3.1 | 2.6 | 2.6 | 2.4 | ... | ... |
| Devil's Food | 2.5 | 3.6 | 3.0 | 2.8 | 2.7 | 3.0 | 2.6 | 2.8 | 2.8 | 2.9 | ... | ... |
| Devil's Food | 1.1 | 3.1 | 3.0 | 2.6 | 2.4 | 3.2 | 2.8 | 2.8 | 2.8 | 2.7 | 2.6 | 2.6 |

higher temperature. Furthermore, these 2 varieties made with 13.7% moisture flour did not withstand a year's storage at 72° F. Maximum mix stability was secured by using a flour of 7.4% moisture content and additional drying of the flour did not increase mix stability. In fact, there is some evidence that mixes containing flour of 3.2% and 2.6% moisture did not withstand storage as well as mixes containing slightly moister flour, as evidenced by more browning and a somewhat greater decrease in specific volume in the driest mixes. This phenomenon is not clear-cut, however.

Table 5 lists the pH values of crumb slurries made from representative test cakes. These data confirm, to a considerable extent, the trends indicated by the specific volume data. The greatest changes in pH occurred in cakes made from the mixes of highest moisture content. Mixes made from flour of 7.4% moisture content or less remained relatively stable, except in the case of the devil's food mix. Mixes made from flour of 7.4% moisture content and above produced cakes of considerably lower pH after one year storage. All of the pH changes observed were in the direction of greater acidity, except for a few anomalous cases probably explainable on the basis of experimental or sampling error. Furthermore, the more alkaline the cake at the beginning of the storage period, the greater was the decline in pH value.

The changes in pH value are perhaps due to the premature reaction of the baking powder components in the mix. This reaction is also responsible for the drop in cake volume, less $CO_2$ being available for leavening when the batter was mixed.

In Figures 1 through 4 are illustrated representative cakes made from mixes described in this article. Not all moisture levels are shown, but those omitted to save space fit into the trend established by the illustrated examples. Figure 5 illustrates the trend in a devil's food cake mix of intermediate moisture content.

The main point established by Figures 1 through 5 is that a significant decline in overall quality is associated with extreme changes in pH and volume. An increase in fragility accompanies storage deterioration. In the lighter colored cakes (white and yellow) browning becomes evident. Contours of the devil's food cakes change, the top crust becomes first concave and later flat, while the other varieties become very flat in profile after a somewhat longer storage period. The grain becomes dense, and spots of unassimilated or unhydrated mix appear in the cake. The crumb becomes very soggy.

Mixes containing flour of 7.4% moisture or less were, in the main, resistant to the manifestations of storage deterioration. To be sure, some browning was observed in the white cake mixes of lowest moisture content, but this effect was not nearly as pronounced as it was in the moister mixes of this variety.

In Table 6 are tabulated the headspace carbon dioxide percentages of representative mixes. Headspace carbon dioxide percentages demonstrated quite clearly the increase in rate of carbon dioxide evolution with increased moisture content. There was some reaction of leavening ingredients in all of the mixes, but below certain moisture levels the rate was very slow. The critical level for white cake mixes appears to be between 2.2% and 2.9%, for yellow cake mixes between 1.8 and 2.0%, for gingerbread mixes between 1.6% and 1.9%, and for devil's food cake mixes between 1.1% and 1.2%.

**TABLE 6**

**Percent of carbon dioxide in headspace gases of canned white cake mixes**

| Moisture content | Storage temperatures | | | | | | |
|---|---|---|---|---|---|---|---|
| | 72° F. | | | | 100° F. | | |
| | Storage time (months) | | | | Storage time (months) | | |
| | 0 | 6 | 12 | 18 | 6 | 12 | 18 |
| % | | | | | | | |
| 5.1 | 2.2 | 9.8 | 18.0 | 24.0 | 44.9 | 60.4 | 72.5 |
| 3.2 | 0.9 | 3.0 | 3.6 | 19.1 | 8.9 | 17.5 | 25.8 |
| 2.9 | 0.6 | 2.7 | 2.0 | 2.7 | 6.0 | 11.2 | 16.6 |
| 2.2 | 0.6 | 0.8 | 0.5 | 0.5 | 2.7 | 3.9 | 5.9 |
| 1.9 | 0.3 | 0.5 | 0.5 | NF | 1.6 | 3.2 | 4.7 |
| 1.3 | 0.3 | 0.4 | 0.5 | 0.8 | 1.7 | 2.5 | 3.9 |
| 1.2 | 0.5 | 0.7 | 0.8 | 0.5 | 1.3 | 1.6 | 2.7 |

In Table 7 are tabulated the percentages of total carbon dioxide in representative samples of the original and stored mixes. The same trends observed in the headspace $CO_2$ data are again seen, although the procedure for total carbon dioxide appears to be much more subject to experimental or sampling error. From these data, the leavening ingredients of the mix are seen to be the source of the carbon dioxide found in the can headspace, as expected.

In Table 8 are tabulated representative data from the free fatty acids determinations. The picture of rapid deterioration in the samples of higher moisture content and little or no deterioration in the driest samples is repeated. However, there appear to be no sharp breaks

**TABLE 5**

**pH values of cakes made from stored devil's food cake mixes**

| Moisture content | Storage temperatures | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 72° F. | | | | 100° F. | | | | | | |
| | Storage time (months) | | | | Storage time (months) | | | | | | |
| | 0 | 6 | 12 | 18 | 1 | 2 | 4 | 6 | 8 | 12 | 18 |
| % | | | | | | | | | | | |
| 4.3 | 9.3 | 8.9 | 8.1 | 8.0 | 8.8 | 9.2 | 8.8 | 7.7 | 7.6 | 7.3 | 6.8 |
| 2.9 | 9.3 | 9.0 | 8.8 | 8.6 | 9.0 | 9.2 | 9.2 | 9.2 | 8.8 | 8.2 | 7.8 |
| 2.5 | 9.4 | 8.9 | 8.8 | 8.8 | 9.0 | 9.3 | 9.2 | 9.1 | 8.9 | 8.5 | 8.1 |
| 2.0 | 9.1 | 9.0 | 9.0 | 8.9 | 9.0 | 9.3 | 9.4 | 9.0 | 9.1 | 9.2 | 8.7 |
| 1.7 | 9.3 | 9.0 | 8.9 | 8.9 | 9.0 | 9.3 | 9.3 | 9.1 | 9.3 | 9.4 | 8.8 |
| 1.2 | 9.3 | 9.1 | 9.0 | 8.8 | 9.0 | 9.4 | 9.4 | 9.3 | 9.3 | 9.3 | 8.7 |
| 1.1 | 9.1 | 9.0 | 9.0 | 8.6 | 9.2 | 9.3 | 9.3 | 9.2 | 9.2 | 9.3 | 8.7 |

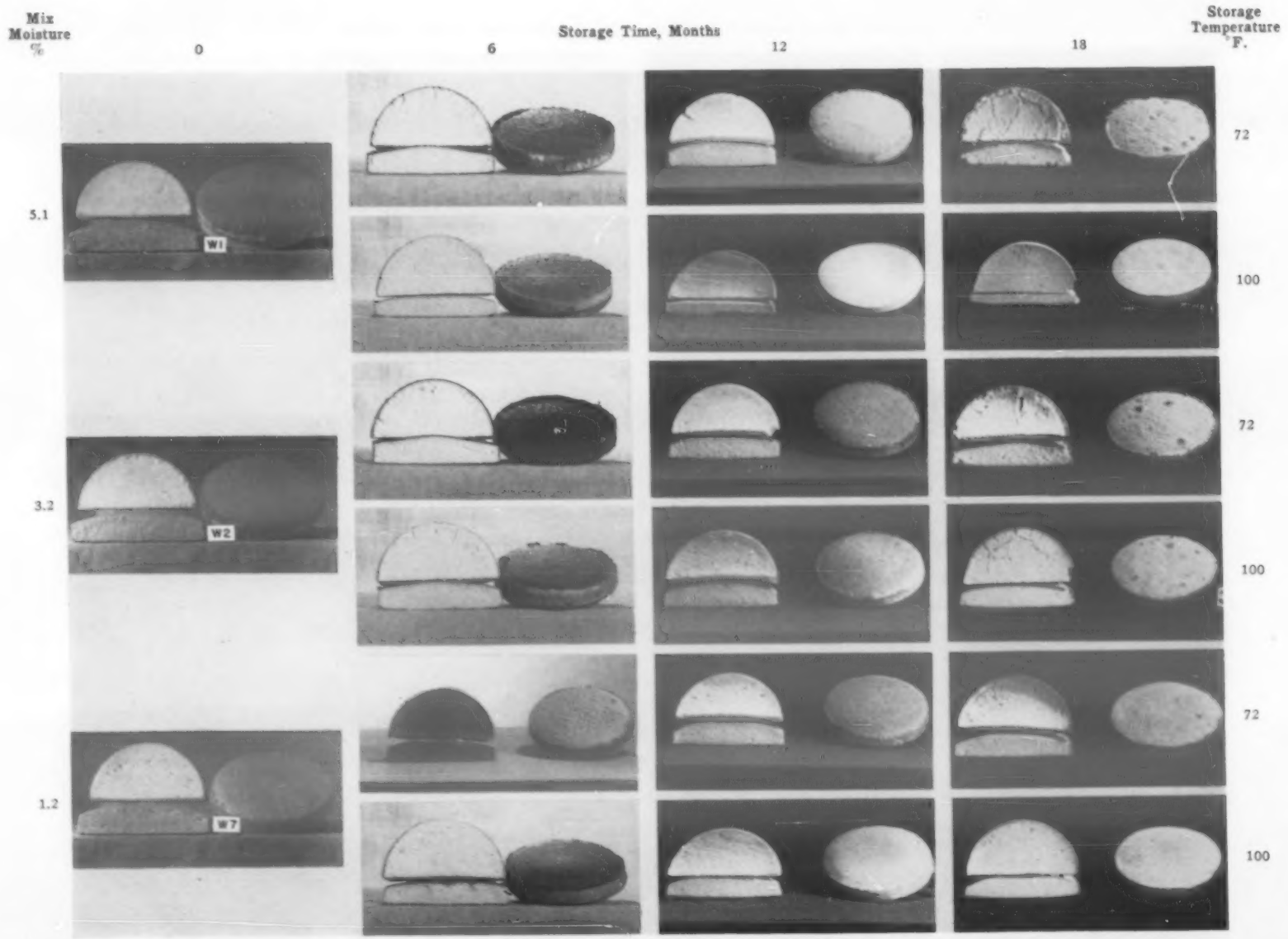


Figure 1. White cakes made from mixes subjected to various storage treatments.

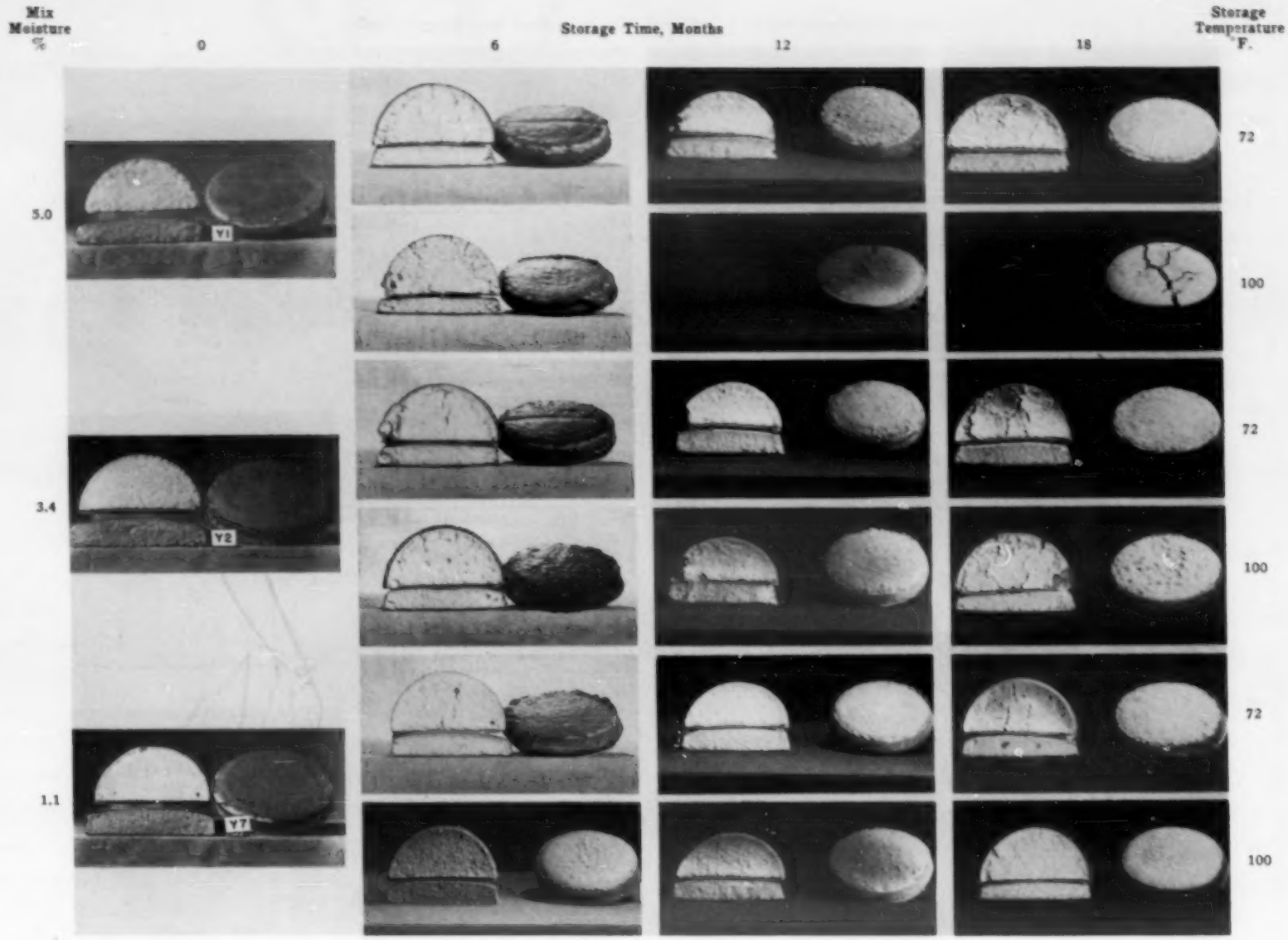


Figure 2. Yellow cakes made from mixes subjected to various storage treatments.

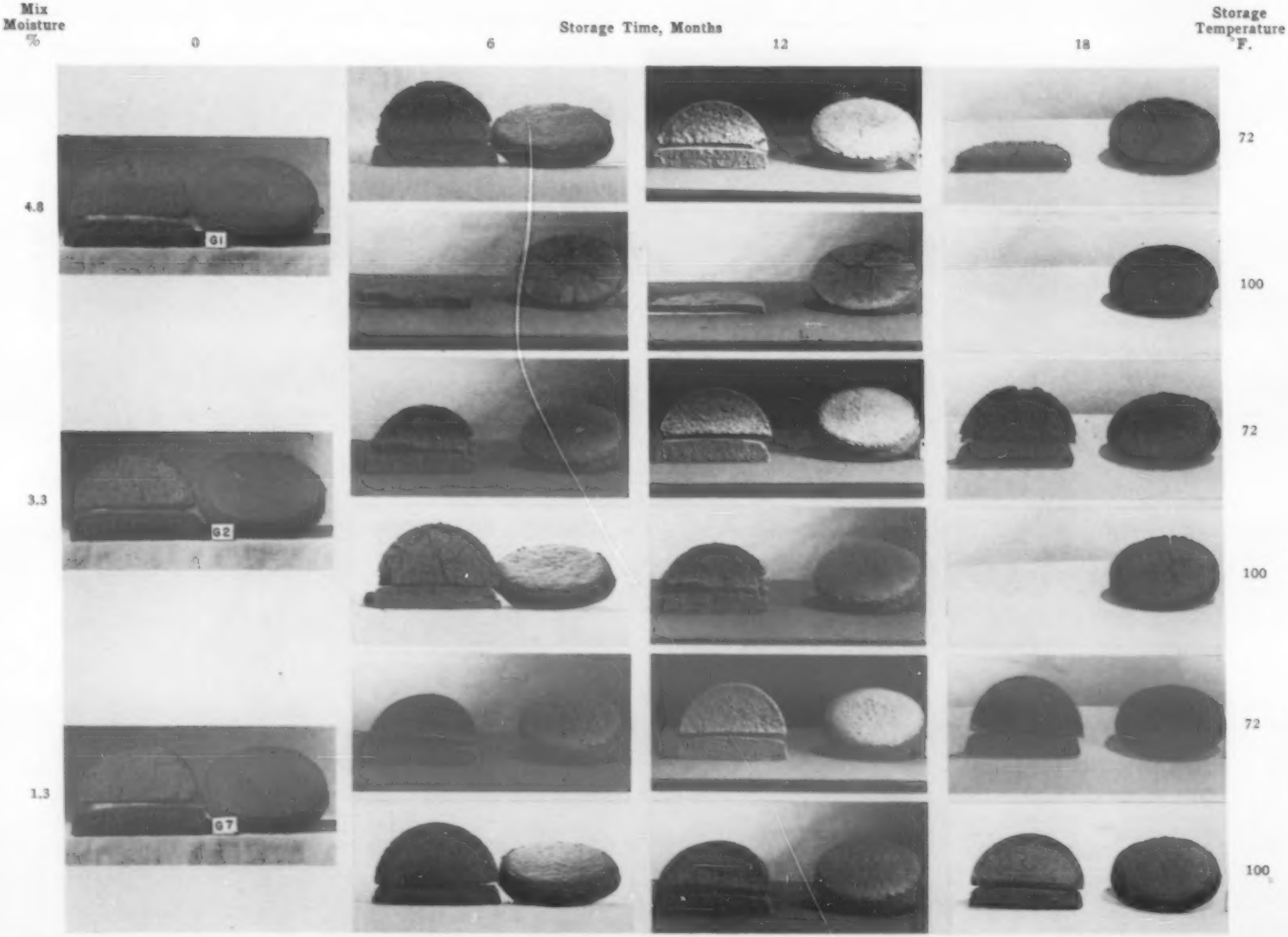


Figure 3. Gingerbread cakes made from mixes subjected to various storage treatments.

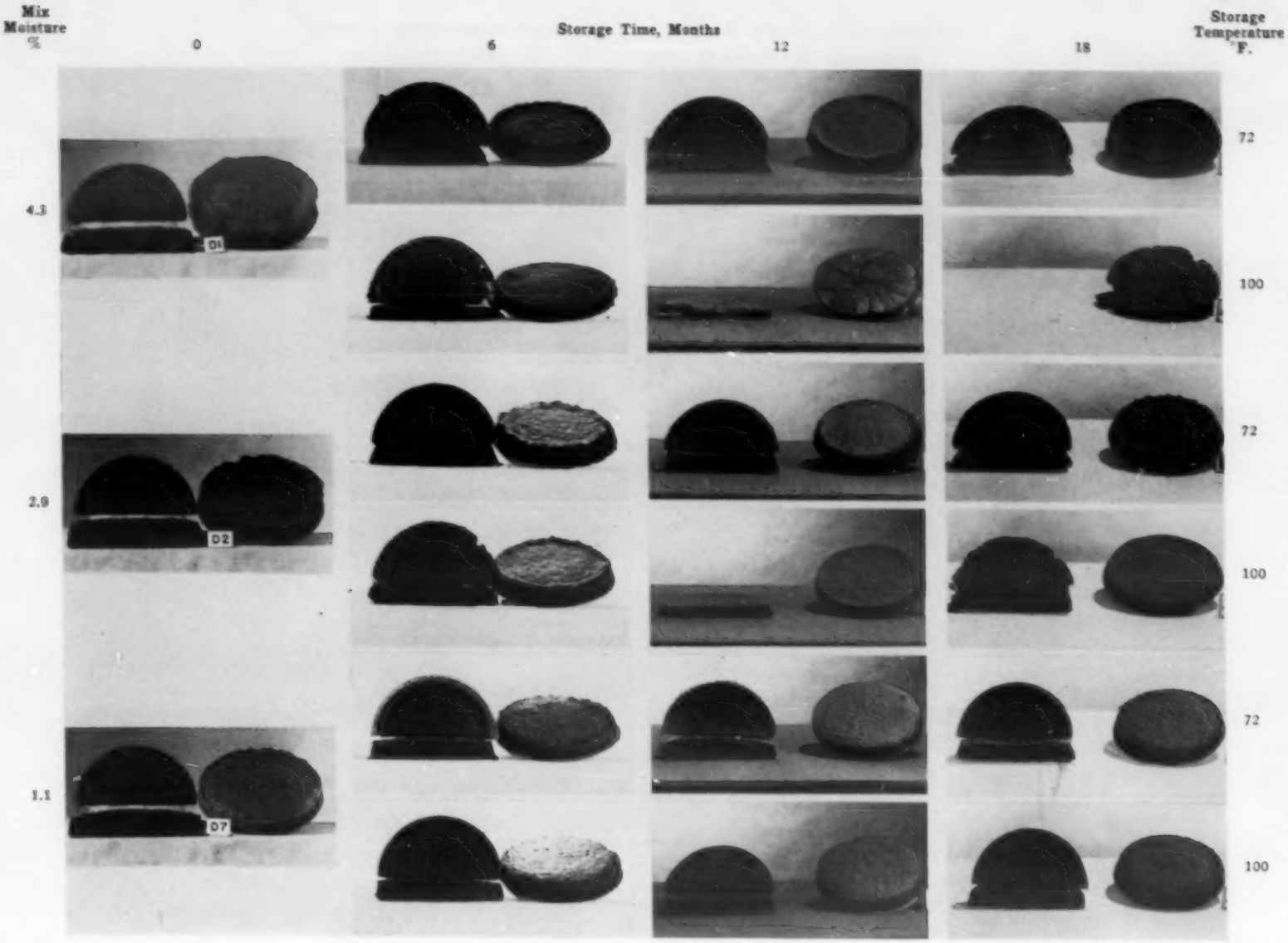


Figure 4. Devil's food cakes made from mixes subjected to various storage treatments.

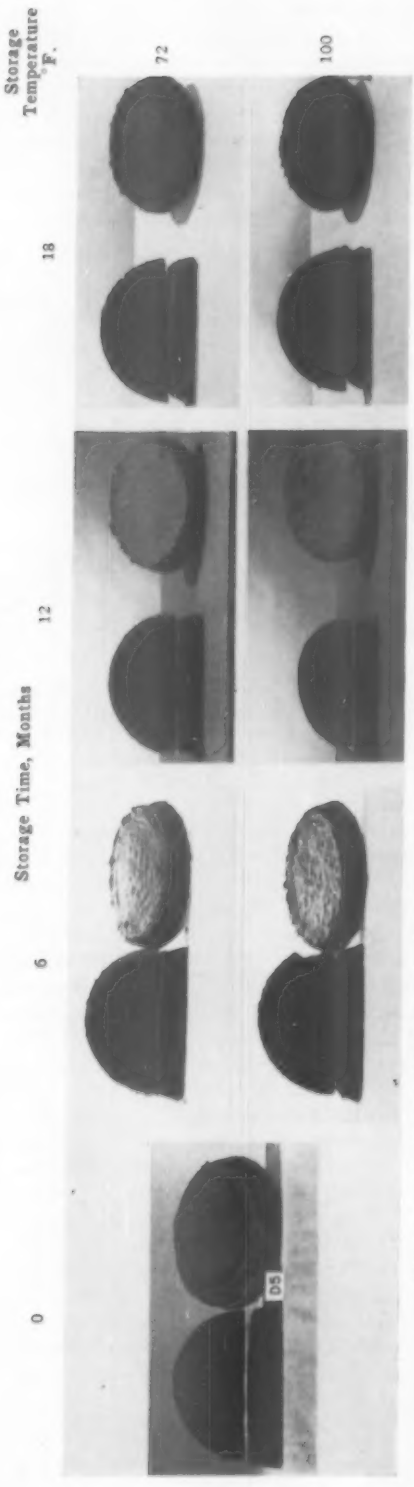


Figure 5. Devil's food cakes made from a mix of 1.7% moisture content stored under various conditions.

indicating a critical level. Rather, there is a gradual decline in free fatty acid production which continues down to the lowest moisture level studied.

Quite a different picture is presented by the data for peroxide values in Table 9. These figures, though rather erratic, show a trend toward faster development of peroxide values in the drier mixes. Little or no increase in peroxides was observed in the 5 mixes of highest moisture content. A considerable increase did occur in the two driest white, devil's food and yellow mixes, but not in the gingerbread mixes. It is interesting that the gingerbread cakes were the lowest in pH of all the varieties. Perhaps this factor has some connection with the absence of peroxide development in the mixes.

Strangely enough, in view of the large fluctuations of pH in the cakes, there were no changes of consequence in the pH values of the mixes themselves. Among those changes which occurred there was no discernible trend.

The carbonyl values also remained relatively constant throughout the period of storage. No changes attributable to deterioration could be discovered. Because of the absence of significant data, the results of these determinations are omitted.

Lipid fluorescence values usually change during storage as a result of reactions of the Maillard type involving phospholipids and sugars or aldehydes, and ending in fluorescent compounds soluble in fat solvents. These values are particularly useful in estimating the amount of staling in products containing egg solids. For these reasons, lipid fluorescence values were determined on the mixes. Changes were erratic, but a gradual increase occurred during the 18 months of storage. The increase appeared to be somewhat accelerated by lower moisture contents and higher temperatures. For example, the white cake mix of lowest moisture content had a lipid fluorescence of 8.3 (microgram equivalents of quinine sulfate per gram of fat) at the start and 8.6 after 18 months at 72° F. and 10.0 after 18 months at 100° F. Equivalent figures for the devil's food cake mix of highest moisture content are 8.4, 14.8, and 14.0, respectively. Other data are omitted to save space.

An increase in saline fluorescence values during storage was expected but these saline fluorescence values showed little change and, for that reason, are not tabulated here. There was a slight increase in saline fluorescence values of the wetter mixtures and, apparently, a slight decrease in the drier mixtures over the total storage period. The temperature of storage apparently had little influence on the rate at which these changes occurred, and the random fluctuations in these analytical values were so large as to render the existence of any significant trend obscure.

## SUMMARY

It has been shown that the rate of deterioration of chemically leavened cake mixes during storage at ordinary or relatively high temperatures is dependent upon the moisture content of the mix and the variety of the mix. Products formulated with flour of 7.4% moisture content, or less, were generally quite resistant to deleterious aging reactions. Mixes producing cakes having

**TABLE 7**
**Effect of storage on total carbon dioxide in cake mixes**

| Mix variety | Moisture content | Storage temperatures | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 72° F. | | | | 100° F. | | |
| | | Storage time (months) | | | | Storage time (months) | | |
| | | 0 | 6 | 12 | 18 | 6 | 12 | 18 |
| | % | % | % | % | % | % | % | % |
| White | 5.1 | 0.59 | 0.25 | 0.16 | 0.16 | 0.12 | 0.05 | 0.05 |
| White | 3.2 | 0.30 | 0.30 | 0.25 | 0.24 | 0.31 | 0.22 | 0.26 |
| Yellow | 5.0 | 0.31 | 0.26 | 0.19 | 0.19 | 0.09 | 0.03 | 0.04 |
| Yellow | 3.4 | 0.19 | 0.32 | 0.25 | 0.26 | 0.26 | 0.19 | 0.14 |
| Yellow | 2.8 | 0.29 | 0.32 | 0.24 | 0.28 | 0.29 | 0.22 | 0.22 |
| Gingerbread | 4.8 | 0.29 | 0.23 | 0.16 | 0.14 | 0.09 | 0.04 | 0.05 |
| Gingerbread | 3.3 | 0.32 | 0.29 | 0.24 | 0.29 | 0.26 | 0.15 | 0.12 |
| Gingerbread | 2.9 | 0.30 | 0.30 | 0.27 | 0.30 | 0.30 | 0.29 | 0.22 |
| Devil's Food | 4.3 | 0.44 | 0.43 | 0.30 | 0.30 | 0.22 | 0.08 | 0.06 |
| Devil's Food | 2.9 | 0.48 | 0.51 | 0.39 | 0.46 | 0.42 | 0.28 | 0.26 |
| Devil's Food | 2.5 | 0.46 | 0.51 | 0.32 | 0.33 | 0.46 | 0.32 | 0.32 |

**TABLE 8**
**Free fatty acids in the fat of stored cake mixes**

| Mix variety | Moisture content | Storage temperatures | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 72° F. | | | | 100° F. | | |
| | | Storage time (months) | | | | Storage time (months) | | |
| | | 0 | 6 | 12 | 18 | 6 | 12 | 18 |
| | % | % | % | % | % | % | % | % |
| White | 5.1 | 0.72 | 1.28 | 2.60 | 3.89 | 3.96 | 14.77 | 22.34 |
| White | 3.2 | 0.37 | 0.47 | 0.61 | 1.58 | 0.75 | 1.55 | 2.08 |
| White | 2.9 | 0.37 | 0.43 | 0.53 | 0.62 | 0.57 | 0.92 | 1.34 |
| White | 2.2 | 0.32 | 0.33 | 0.36 | 0.39 | 0.36 | 0.48 | 0.60 |
| White | 1.9 | 0.24 | 0.31 | 0.35 | 0.36 | 0.31 | 0.41 | 0.49 |
| White | 1.3 | 0.25 | 0.28 | 0.30 | 0.30 | 0.26 | 0.30 | 0.34 |
| White | 1.2 | 0.21 | 0.27 | 0.28 | 0.28 | 0.22 | 0.26 | 0.30 |
| Devil's Food | 4.3 | 1.05 | 2.22 | 3.64 | 4.20 | 4.54 | 11.15 | 17.72 |
| Devil's Food | 2.9 | 0.81 | 1.06 | 1.60 | 1.96 | 1.59 | 3.66 | 3.34 |
| Devil's Food | 2.5 | 0.83 | 0.90 | 1.24 | 1.44 | 1.27 | 2.67 | 2.60 |
| Devil's Food | 2.0 | 0.84 | 0.78 | 0.94 | 1.06 | 0.92 | 1.63 | 1.74 |
| Devil's Food | 1.7 | 0.79 | 0.77 | 0.83 | 0.90 | 0.75 | 1.06 | 1.21 |
| Devil's Food | 1.2 | 0.74 | 0.67 | 0.66 | 0.70 | 0.67 | 0.71 | 0.80 |
| Devil's Food | 1.1 | 0.67 | 0.70 | 0.82 | 0.68 | 0.65 | 0.62 | 0.71 |

**TABLE 9**
**Peroxide values of fat of stored cake mixes** [1]

| Mix variety | Moisture content | Storage temperatures | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 72° F. | | | | 100° F. | | |
| | | Storage time (months) | | | | Storage time (months) | | |
| | | 0 | 6 | 12 | 18 | 6 | 12 | 18 |
| | % | % | % | % | % | % | % | % |
| White | 5.1 | NF | 3.1 | 4.9 | 1.8 | 4.7 | 2.5 | NF |
| White | 3.2 | NF | 2.5 | 3.4 | 1.9 | 4.7 | 3.1 | NF |
| White | 2.9 | NF | 2.3 | 2.7 | 2.0 | 3.4 | 3.6 | NF |
| White | 2.2 | NF | 4.0 | 2.6 | 1.8 | 4.3 | 7.6 | 20.6 |
| White | 1.9 | NF | 2.0 | 3.2 | 7.2 | 3.8 | 20.2 | 33.0 |
| White | 1.3 | 13.0 | 15.7 | 23.0 | 24.1 | 5.7 | 35.1 | 36.2 |
| White | 1.2 | 11.0 | 10.9 | 14.5 | 15.9 | 15.4 | 20.7 | 19.8 |
| Gingerbread | 4.8 | NF | 1.7 | 1.8 | 0.8 | 0.4 | 2.0 | 1.8 |
| Gingerbread | 3.3 | NF | 0.6 | 2.7 | 2.0 | 0.6 | 1.6 | 0.4 |
| Gingerbread | 2.9 | NF | 0.5 | 2.0 | 1.5 | 1.0 | 3.2 | 2.4 |
| Gingerbread | 2.2 | NF | 4.0 | 2.6 | 1.7 | 2.4 | 2.6 | 4.3 |
| Gingerbread | 1.9 | NF | 4.2 | 2.3 | 2.2 | 0.2 | 3.7 | 3.8 |
| Gingerbread | 1.6 | NF | 4.4 | 2.9 | 3.0 | 0.9 | 2.2 | 3.7 |
| Gingerbread | 1.3 | 6.3 | 3.8 | 2.6 | 4.4 | 1.7 | 2.9 | 4.1 |

[1] Milliequivalents per gram of fat.

crumb of nearly neutral pH were more stable than mixes producing cakes having more alkaline crumb.

Changes in the physical properties of cakes resulting from storage of the mixes are due primarily to a premature reaction of the leavening ingredients. Carbon dioxide normally available during the baking period is lost as a result of this reaction, and substances having a weakening effect on the gluten structure are accumulated in the aged mix. The final result is a cake of low specific volume, altered pH, and soggy and fragile texture.

Another change occurring in stored mixes of moderate to high moisture contents is an increase in free fatty acids. On the other hand, a considerable increase in

peroxide value of the ether extractables is found in the drier mixes, while the peroxide values of higher moisture content mixes are nearly unaffected by storage.

Higher moisture contents appear to accelerate slightly the increase in saline fluorescence during storage, whereas the opposite is true for lipid fluorescence. These changes are not extreme, however.

Factors apparently unaffected by storage under the conditions employed in this experiment are pH of the mixes and their carbonyl values.

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# Some Factors Affecting Bacterial Counts of Soft Ice Milk[a]


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**The effect of time and temperature of plate incubation on the bacterial counts of soft ice milk has been studied. An attempt was made to trace the sources of high bacterial counts in this product.**


During recent years there has been a great increase in the volume of soft ice milk sold. The product is a low fat dessert served directly from the freezer under various trade names. The composition of soft ice milk shows wide variations as do the laws in various states for this product. The fat content usually varies from 2 to 6%, serum solids from 11 to 16%, sugar (including corn sweeteners) from 12 to 18%, and stabilizer and emulsifier together from 0.4 to 0.6%. Soft ice milk is frozen from mixes prepared either at a mix-making plant and then shipped to the freezer operator or prepared at the retail outlet from a reconstituted powdered mix. Commonly, mixes are held under refrigeration at the retail outlet for several days, sometimes a week, particularly when sales are slow. The microorganisms (psychrophiles) which develop during this period must be capable of growing at low temperature.

In an ice milk survey conducted by this laboratory *(15)* high standard plate counts (>100,000 bacteria/ml.) were found in 19 out of 50 samples submitted for analysis by freezer operators in 19 Texas towns. The plates in those studies were incubated at 32° C. In recent years, however, lower plate incubation temperatures have been used to determine the bacterial count of dairy products held under refrigeration. In plating pasteurized milk, cream, and chocolate milk, Watrous, Doan, and Josephson *(16)* reported that the counts at 25° C. usually were considerably higher than those obtained at 35° C. Atherton, Doan, and Watrous *(2)* found that incubation at 32, 26, and 20° C. gave almost identical counts on refrigerated bottled milk. After holding for 3 days, the counts at 35° C. lagged far behind those obtained at the lower incubation temperatures. Nelson and Baker *(11)* reported maximum counts on stored samples of milk, cream, skim milk and half-and-half at a plate incubation of 3 days at 25° C. Counts at 35° C. usually were considerably lower than those at 25 and 21° C., whereas counts at 32° C. usually were quite close to those at 25 and 21° C. In *Standard Methods for the Examination of Dairy Products (1)* an incubation temperature of 32 or 35° C. is recommended for standard plate count; for detection of bacteria growing at refrigeration temperature, 5° C. for 7 days.

Although many investigators have used plate incubation temperatures ranging from 4-10° C., low incubation temperatures are not necessary to determine psychrophilic bacteria unless a separate enumeration is desired. Nelson and Baker *(11)* showed that if the plates were incubated at 25° C. for 3 days, all samples giving high counts on plates incubated at 5° C. for 10 days could be detected. Furthermore, others *(5, 10, 13)* reported that 20-25° C. was the optimum temperature for growth of most organisms growing at refrigeration temperature.

The purpose of the present study was (a) to determine the effect of time and temperature of plate incubation on bacterial counts of soft ice milk, and (b) to trace the sources of high bacterial count of the finished product.

## EXPERIMENTAL METHODS

The samples of soft ice milk used in this study were purchased from, or submitted for examination by freezer operators in 19 Texas towns. They were refrigerated with dry ice, shipped to

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the laboratory, and examined bacteriologically the day obtained. Plate counts on TGEM agar were obtained by using the volumetric method *(1)*. Plates were incubated at 55°, 45°, 35°, and 32° C. for 2 days, 25° C. for 2 and 3 days, 21° C. for 2, 3, and 4 days, 15° C. for 3, 5, and 7 days, 10° C. for 5, 7, and 10 days, and 5° C. for 5, 7, and 10 days. Duplicate plates of each dilution were made for each time and temperature combination used in this experiment. Colonies were counted with the aid of a Quebec colony counter. Coliform counts were made on violet-red bile agar with plate incubation at 35° C. for 24 hours *(1)*. Proteolytic counts were made on TGE agar to which 5% of sterile skimmilk was added. Lipolytic bacteria were counted on TGE agar to which 5 ml. of sterile 0.2% aqueous nile blue sulfate solution and 5 ml. of a coconut oil emulsion *(9)* were added per 100 ml. of agar just before pouring plates. The plates for proteolytic and lipolytic bacteria were incubated at 21° C. for 5 days, and 5° C. for 10 days.

## RESULTS

**Effect of time and temperature of plate incubation on bacterial counts.** Data on the effect of plate incubation time on the count at different plate incubation temperatures are presented in Table 1.. For each plate incubation temperature the total count of each sample at the shorter plate incubation time was expressed as percentage of the count obtained after maximum plate incubation time. The mean then was calculated arithmetically for the 50 samples. At all incubation temperatures lower counts usually were found when the incubation time was shortened. This was particularly true for the plates incubated at 5° C. for 5 days. The range of counts at different incubation temperatures shows that a few samples gave considerably lower counts when the incubation time was shortened. At the shorter incubation times the colonies occasionally were difficult to count because of the small size; this was more frequently noted at incubation temperatures of 5° and 10° C.

Effect of plate incubation temperature on the plate count after maximum plate incubation time is shown by data in Table 2. Total count of each sample at plate incubation temperatures of 35°, 32°, 21°, 15°, 10°, and 5° C. was expressed as percentage of the count obtained at a plate incubation temperature of 25° C. The mean then was calculated arithmetically for the 50 samples. The count at 25° C. for 3 days was chosen as 100 since the literature indicates (a) that counts (in milk) at 25° C. usually are essentially the same as at 32° C., and (b) that temperatures of 20-25° C. are optimum for growth of many organisms growing at refrigeration temperature. The majority of the samples gave a low percentage of the maximum count (25° C., 3 d.) when incubated at 35° C. Incubation of plates at 32°, 25°, 21°, and 15° C. gave nearly the same counts. However, the range of counts shows that an occasional sample gave a much lower count at 32°, 21°, and 15° C. than at 25° C. The percentage of maximum count when incubated at 5° C. was much lower than with incubation at 32°, 25°, 21°, 15°, and 10° C. Two samples yielded counts at 32° C. approximately twice the maximum count, which explains the high figures for the range of counts at 32° C.

A comparison of the plate counts with plate incubation at 32° and 45° C. is presented in Table 3. The great majority of the samples with counts of 51,000 or more at 32° C. had a much lower count at 45° C. Of the 15 samples having counts at 32° C. in excess of 1,000,000 per ml., 7 had counts of less than 1,000 per ml. at 45° C. This temperature seemed highly unfavorable for the majority of types of organisms present in soft ice milk.

All ice milk samples had less than 1,000 thermophilic bacteria per ml. The small numbers of thermophilic bacteria in ice milk may be due to the detrimental effect of storage at refrigeration temperatures as has been shown for milk *(3, 8, 14)*.

The influence of plate incubation temperature on the number of ice milk samples which would have rated as unacceptable according to an assumed bacteriological standard was determined. A count of 100,000 bacteria or less per ml. after maximum incubation time (see Table 2) has been chosen arbitrarily as the standard. Data on the counts of the individual samples revealed that with plate incubation at 35°, 32°, 25°, 21°, 15°, 10°, and 5° C. the number of samples rated as unacceptable would have been 11, 19, 20, 20, 20, 17, and 16, respectively.

Data showing the relationship between proteolytic counts at plate incubation temperatures of 21 and 5° C., and between lipolytic counts at 21 and 5° C. are presented in Table 4. Of the 14 samples having proteolytic counts at 21° C. in excess of 1,000 per ml., 12 had proteolytic counts in this range at 5° C., while the other 2 samples had proteolytic counts ranging from 101 to 1,000 per ml. Some tendency for high proteolytic counts at 21° C. to be associated with high proteolytic counts at 5° C. was present. The same was true for the lipolytic counts. Both the proteolytic and lipolytic counts, however, were very small in relation to the total counts at both incubation temperatures. Counts on the individual samples indicate that the proteolytic count at 21° C. was only 0 to 13% (median 0.42) of the total count at 21° C. (4 d.). The same figures for the lipolytic counts were 0 to 15% (median 0.12).

**Factors associated with high bacterial counts.** Approximately 50% of the samples with high bacterial count were frozen from mixes which originated at a plant where each mix was examined bacteriologically and showed a low bacterial count. An attempt was made to trace the source(s) of the high bacterial counts. Samples of ice milk mix were taken at various places between pasteurization at the mix-making plant and freezing at 3 freezer operators' establishments designated as A, B, and C. The samples were placed in sterile screw-cap bottles, shipped to the

**TABLE 1**

**Effect of plate incubation time on plate counts at different temperatures of 50 samples of ice milk**

| Incubation temperature | 25° C. | 21° C. | | 15° C. | | 10° C. | | 5° C. | |
|---|---|---|---|---|---|---|---|---|---|
| Maximum incubation time (days) | 3 | 4 | | 7 | | 10 | | 10 | |
| Incubation time (days) | 3 | 2 | 3 | 3 | 5 | 5 | 7 | 5 | 7 |
| Mean | 88 | 83 | 95 | 76 | 91 | 82 | 90 | 51 | 80 |
| Median | 91 | 85 | 95 | 78 | 92 | 77 | 86 | 46 | 84 |
| Range | 40-103 | 26-111 | 69-108 | 20-113 | 61-110 | 62-131 | 64-121 | 9-97 | 35-100 |

[1] The count at the shorter plate incubation time (2 days) was expressed as percentage of the count obtained after maximum plate incubation time (3 days).

**TABLE 2**

**Comparison of counts[1] at different temperatures at maximum plate incubation time for 50 samples of ice milk**

| Incubation temperature | 35° C. | 32° C. | 25° C. | 21° C. | 15° C. | 10° C. | 5° C. |
|---|---|---|---|---|---|---|---|
| Maximum incubation time (days) | 2 | 2 | 3 | 4 | 7 | 10 | 10 |
| Mean | 40 | 98 | 100 | 102 | 100 | 81 | 68 |
| Median | 45 | 95 | 100 | 104 | 103 | 90 | 64 |
| Range | 1-103 | 30-200 | ..... | 68-131 | 25-126 | 23-131 | 11-125 |

[1] The counts at 35° C. (2 d.), 32° C. (2 d.), 21° C. (4 d.), 15° C. (7 d.), 10° C. (10 d.), and 5° C. (10 d.) were expressed as percentage of the count obtained at a plate incubation of 25° C. (3 d.).

**TABLE 3**

**Comparison of plate counts at 32 and 45° C. on 50 samples of ice milk**

| Standard plate count at 32° C. | No. of samples with counts/ml. at 45° C. of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <1 T | 1T-5T | 5.1T-10T | 11T-50T | 51T-100T | 101T-500T | 510T-1M | Totals |
| <1T[1] | 1 | | | | | | | 1 |
| 1T-5T | 4 | 1 | | | | | | 5 |
| 5.1T-10T | 6 | | | | | | | 6 |
| 11T-50T | 9 | 2 | 2 | | | | | 13 |
| 51T-100T | 3 | 1 | 2 | | | | | 6 |
| 101T-500T | | | | 1 | 2 | | | 3 |
| 510T-1M[2] | | | 1 | | | | | 1 |
| >1M | 7 | 1 | 2 | 2 | 1 | 1 | 1 | 15 |
| Totals | 30 | 5 | 7 | 3 | 3 | 1 | 1 | 50 |

[1] T = thousand.
[2] M = Million.

**TABLE 4**

**Comparison of counts of proteolytic and lipolytic bacteria on 50 samples of ice milk at different plate incubation temperatures and times**

| Proteolytic count/ml. at 21° C. | Number of samples with proteolytic counts/ml. at 5° C. of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <1 | 1-10 | 11-100 | 101-1T | 1.1T-5T | 5.1T-10T | >10T | Totals |
| <1 | 3 | 1 | 2 | 1 | 1 | | | 8 |
| 1-10 | 2 | 1 | 3 | | | | | 6 |
| 11-100 | 2 | 3 | 5 | | | | | 10 |
| 101-1T[1] | 1 | 2 | 2 | 5 | 2 | | | 12 |
| 1.1T-5T | | | | 1 | 2 | | | 3 |
| 5.1T-10T | | | | 1 | 1 | 2 | | 4 |
| >10T | | | | | | | 7 | 7 |
| Totals | 8 | 7 | 12 | 8 | 6 | 2 | 7 | 50 |

| Lipolytic count/ml. at 21° C. | Number of samples with lipolytic counts/ml. at 5° C. of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <1 | 1-10 | 11-100 | 101-1T | 1.1T-5T | 5.1T-10T | >10T | Totals |
| <1 | 6 | 2 | | | | | | 8 |
| 1-10 | 2 | 6 | 2 | | | | | 10 |
| 11-100 | 1 | 1 | 5 | 4 | | | | 11 |
| 101-1T | | 1 | 4 | 4 | | | | 9 |
| 1.1T-5T | | | | | 3 | | | 3 |
| 5.1T-10T | | | | | | 3 | | 3 |
| >10T | | | | | | | 6 | 6 |
| Totals | 9 | 10 | 11 | 8 | 3 | 3 | 6 | 50 |

[1] T = thousand.

laboratory refrigerated with ice, and were plated on the same day.

Mixes shipped to A, B, and C in refrigerated trucks had a low bacterial count (Table 5). Storage at A for 2 days at 2.2° C. (36° F.), followed by freezing, did not cause significant changes in the bacterial count. Storage at B and C for 2 days at temperatures of 7.2° C. (45° F.) and 11.2° C. (52° F.), however, caused a significant increase in total count. An additional increase in count was observed following freezing of these 2 mixes. Both samples (B and C) showed a coliform count after freezing of more than 10 per ml. which should be considered as unsatisfactory. Significant increases in both proteolytic and lipolytic counts were noted at the higher storage temperatures.

**TABLE 5**

**Bacteriological examination of ice milk from mix manufacturing plant to freezer operator**

| Source of the sample | S.P.C./ml. at 32° C. | Coliform count/ml. | Proteolytic count/ml. at 21° C. | Lipolytic count/ml. at 21° C. |
|---|---|---|---|---|
| 1. Mix after holding period 30 min. at 71.1° C. (160° F.) | 6,500 | 1 | 2 | 1 |
| 2. Mix at bottom of surface cooler 1.7° C. (35° F.) | 7,100 | 2 | 4 | 15 |
| 3. Cans before filling mix[1] | <1 | <1 | <1 | <1 |
| 4. Mix[2] before transport to A | 7,200 | 3 | 5 | 12 |
| Mix at A after 2 days storage at 2.2° C. (36° F.) | 11,000 | 5 | 12 | 63 |
| Mix at A after freezing | 14,000 | 3 | 39 | 80 |
| 5. Mix[2] before transport to B | 7,900 | 2 | 12 | 21 |
| Mix at B after 2 days storage at 7.2° C. (45° F.) | 26,000 | 6 | 120 | 290 |
| Mix at B after freezing | 44,000 | 21 | 170 | 1,100 |
| 6. Mix[2] before transport to C | 6,100 | 2 | 2 | 5 |
| Mix at C after 2 days storage at 11.2° C. (52° F.) | 54,000 | 11 | 15 | 1,600 |
| Mix at C after freezing | 64,000 | 53 | 40 | 2,300 |

[1] Number of colonies/can.
[2] One 10-gallon can of mix was tagged and used for analysis.

A periodic bacteriological examination at one mix-making plant of mixes shipped to approximately 30 freezer operators indicated that high bacterial counts in the frozen product probably were due to undesirable practices at the freezer operator's establishment. This conclusion is supported by data presented in Tables 5 and 6. A formal inspection of 10 establishments (Table 6) showed some of the factors which could have contributed to high bacterial counts. Inadequate mix storage facilities were found in 2 of the 10 establishments inspected. In both cases the refrigeration system had been out of order for some time. The mix was kept under moderate refrigeration with ice. The temperature of the mix ranged from 50 to 55° F., which is too high. The temperature of the mixes in the 10 establishments ranged from 33° to 72° F. A temperature of 42° F. or lower was considered satisfactory. In certain coolers fruits and vegetables were stored on top of the cans containing mix. An inspection of cleaning and sanitizing practices (see Table 6) showed that not all the equipment and utensils were thoroughly cleaned and sanitized. This, undoubtedly, could be one factor contributing to high bacterial counts.

Although sanitation at the "soft ice milk" establishment was a factor in many instances, others such as temperature and time of storage may be responsible for, or contribute to, high counts of mixes initially having a low bacterial count. Ice milk mixes

**TABLE 6**
**Inspection of 10 "soft ice milk" establishments for mix handling and sanitation of equipment**

| Items inspected | Establishment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Mix storage: | | | | | | | | | | |
| Facilities | X[1] | | | | | | | | X | |
| Mix temperature | X | X | | | | | | X | X | |
| Undesirable materials in cooler | X | | X | | | | | X | | |
| Flavor and color: | | | | | | | | | | |
| Cleaning of measuring devices | X | | X | X | | | | | X | |
| Sanitizing | X | X | X | X | X | X | X | X | X | |
| Cleaning of stirring rod | | | | | | | | | | |
| Sanitizing | X | X | X | X | X | X | X | X | X | X |
| Preparation and/or storage | X | | X | X | | | | X | X | |
| Freezer: Cleaning and sanitizing | | | | | | | | | | |
| Cylinder | | | | | | | | | | |
| Cleaning | | | | X | | | | X | X | |
| Sanitizing | | X | | X | | | X | X | X | |
| Pumps | | | | | | | | | | |
| Cleaning | X | | X | X | | | | X | X | |
| Sanitizing | X | | X | X | | | | X | X | |
| Pipelines | | | | | | | | | | |
| Cleaning | X | | X | X | | | | X | X | |
| Sanitizing | X | | X | X | | | | X | X | |

[1] X = Unsatisfactory.

have to be stored for several days, sometimes a week, at the freezer operator's establishment, particularly when sales are slow because of bad weather. A study was made of the influence of time and temperature of storage of ice milk mix on the changes in bacterial count.

Five samples of pasteurized mix were obtained from two mix-making plants. The mixes were placed in sterile jars and shipped to the laboratory refrigerated with ice. Portions (50 ml.) of each mix were transferred aseptically to sterile screw-cap bottles and stored at 2-5° C., 5-8° C., and 9-12° C. The range in temperature represents the lowest and highest reading in the cooling cabinet over a period of 6 days. Total count and coliform count were determined after 0, 2, 4, and 6 days of storage.

The data (Table 7) indicate that all mixes, with the exception of mix No. 3, could be stored at temperatures ranging from 2-5° C. (35.6-41° F.) for 4-6 days without excessive increases in total count and coliform count. Mix No. 3 was a reconstituted powdered mix which had a relatively high total count and an excessive coliform count at the beginning of the storage period. Holding mixes at 5-8° C. (41-46.4° F.) resulted in a small increase in count after 2 days and in larger increases in count after 4 days. The same was true for the sample stored at 9-12° C. (48.2-53.6° F.); however, the increases in count were more pronounced at the higher storage temperatures.

No significant increases in the coliform count were observed at 2-5° C. (35.6-41° F.) even after 6 days. The coliform counts at 5-8° C. (41-46.4° F.) are inconsistent. In some cases (samples 3 and 5) considerable increases in coliform count were noted, whereas others (samples 2 and 4) showed little or no increase. Storage at 9-12° C. (48.2-53.6° F.) showed significant increases in coliform count after only 4 days.

## DISCUSSION

The present study, as well as those of Watrous, Doan, and Josephson *(16)*, Atherton, Doan, and Watrous *(2)*, and Nelson and Baker *(11)*, indicate that plate incubation temperatures ranging from 32° to 15° C. can be used successfully to determine the bacterial counts of dairy products held at refrigeration temperatures. Although a plate incubation temperature of either 32° or 35° C. is recommended by *Standard Methods for the Examination of Dairy Products (1)*, incubation at 35° C. failed in this study to detect many samples which gave high bacterial counts at lower plate incubation temperatures. Incubation at 32° C. would have detected nearly all samples with high bacterial counts, although the counts of some samples were somewhat lower than at 25°, 21°, or 15° C. A few samples with high bacterial counts would not have been detected when incubated at 10° or 5° C. Apparently some of the organisms which develop during refrigerated storage develop very slowly at these temperatures. Incubation of plates at 25°, 21°, or 15° C. gave maximum counts and would have detected all samples with high counts at either 5° or 10° C.

To determine bacterial counts of mixes held under refrigeration, incubation at 25° or 21° C. seems preferable over that at 5° C. for 7 days as recommended by *Standard Methods for the Examination of Dairy Products (1)* for the following reasons: (a) the counts are available sooner, (b) less equipment is necessary, and (c) colonies at 5° C. after 7 days are frequently difficult to count. Incubation at 15° C. for 7 days does not seem to offer any special advantages.

In view of the effect of refrigeration temperatures on thermophilic bacteria in pasteurized milk *(3, 8, 14)* the small numbers of these organisms in soft ice milk is not surprising. It may also indicate that the original mix ingredients, some of which received two or more heat treatments, were relatively free of thermophiles. Although high counts at 45° C. were associated with high

**TABLE 7**
**Changes in standard plate and coliform counts of ice milk mixes during storage at different temperatures**

| Mix no. | Storage temp. (° C.)[1] | Standard plate count/ml.[2] at 32° C. after | | | | Coliform count/ml. after | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 days | 2 days | 4 days | 6 days | 0 days | 2 days | 4 days | 6 days |
| 1 | 2-5 | 6.1 | 7.8 | 9.8 | 62 | 1 | <1 | 1 | 1 |
| 1 | 5-8 | 6.1 | 9.6 | 101 | 2,500 | 1 | 1 | 6 | 33 |
| 1 | 9-12 | 6.1 | 11 | 620 | 22,000 | 1 | 7 | 230 | >1,000 |
| 2 | 2-5 | 2.7 | 2.1 | 4.3 | 19 | <1 | <1 | <1 | <1 |
| 2 | 5-8 | 2.7 | 5.1 | 150 | 12,000 | <1 | <1 | <1 | <1 |
| 2 | 9-12 | 2.7 | 7.2 | 610 | 21,000 | <1 | <1 | <1 | <1 |
| 3 | 2-5 | 40 | 79 | 110 | 1,600 | 46 | 25 | 37 | 45 |
| 3 | 5-8 | 40 | 120 | 3,400 | 16,000 | 46 | 120 | 4,200 | 45,000 |
| 3 | 9-12 | 40 | 92 | 4,800 | 81,000 | 46 | 230 | 15,000 | 330,000 |
| 4 | 2-5 | 7.6 | 8.6 | 13 | 32 | 3 | 1 | <1 | 2 |
| 4 | 5-8 | 7.6 | 12 | 280 | 8,200 | 3 | 5 | 3 | 11 |
| 4 | 9-12 | 7.6 | 43 | 890 | 17,000 | 3 | 11 | 43 | 6,300 |
| 5 | 2-5 | 9.5 | 9.2 | 21 | 96 | 5 | 4 | 7 | 11 |
| 5 | 5-8 | 9.5 | 18 | 320 | 14,000 | 5 | 9 | 270 | 5,300 |
| 5 | 9-12 | 9.5 | 64 | 1,900 | 31,000 | 5 | 25 | 1,200 | >100,000 |

[1] 2-5° C. (35.6-41° F.), 5-8° C. (41-46.4° F.), 9-12° C. (48.2-53.6° F.).
[2] In thousands.

counts at 32° C., counts at 45° C. furnish little information. A plate incubation temperature of 45° C. seemed unfavorable for many organisms present in these samples.

High proteolytic and lipolytic counts usually were associated with high total counts at 10° or 5° C. However, many samples with high total count at 10° or 5° C. showed only a very small number of these organisms. Generally, the proteolytic and lipolytic count was only a very small percentage of the total count at 25° C., which is in agreement with the findings of Watrous, Doan, and Josephson *(16)* on refrigerated pasteurized milk. Brandsaeter *(4)*, however, reported that high psychrophilic counts in raw milk were always associated with high proteolytic and lipolytic counts. Proteolysis is reported to be noticeable at counts of approximately 100,000,000 per ml. *(7)*. On the other hand, cases of high counts have been reported without noticeable defect *(6, 12, 13)*. This lack of relation between proteolytic count and degree of protein breakdown seems to indicate that proteolytic counts are of little value in determining the time necessary for a defect to occur or the extent of such defect.

The data indicate that inadequate cleaning and sanitizing of equipment at the retail outlet could be one of the factors contributing to high bacterial counts in ice milk. On the other hand, holding mix for several days under moderate refrigeration may result in considerable increases in total count, particularly when temperatures above 5° C. (41° F.) are used. Significant increases in coliform count usually occurred when the storage temperature reached 9° C. (48.2° F.), although in some cases increases were noted at 5-8° C. (41-46.4° F.). Thorough cleaning and sanitizing of equipment at the retail outlet and storage of the mix at temperatures below 5° C. (41° F.) should enable the freezer operator who starts with a mix of low bacterial count to produce a product of high sanitary quality.

## SUMMARY

Incubation of plates at 25° C. for 3 days or 21° C. for 4 days gave maximum counts and is recommended for enumeration of bacteria in frozen desserts made from mixes held at refrigeration temperatures. When plates were incubated at 25 or 21° C., all samples giving high counts on plates incubated at 5 or 10° C. could be detected. Incubation at 35° C. frequently failed to detect samples with high counts at lower incubation temperatures. Only small numbers of thermophilic organisms were found in soft ice milk. The proteolytic and lipolytic count usually was very low in relation to the total count. Inadequate sanitation at the retail outlet and holding of the mix at too high a temperature for too long are some of the factors contributing to high bacterial counts in soft ice milk.

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# Dehydrated Pork Studies. Removal of Glucose by Yeast Fermentation[a]

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**Laboratory trials indicated that the storage life of dehydrated pork can be extended by reducing the glucose content. The size of the meat particles influenced the fermentation rate of glucose. When meat particles of ⅛-inch-grind were used, approximately 50 per cent of the glucose was removed. Fermenting the meat with 5 or 10 per cent yeast for 4 to 8 hours yielded a desirable product. When cooked meat was fermented, then dehydrated, the shelf life of the dehydrated product was further improved.**

Dehydrated pork prepared in a multi-stage vacuum drying cabinet, during the summer of 1952 at the Wilson and Company Research Laboratories, Chicago, developed an undesirable color and flavor when stored under vacuum. Various investigators *(4, 7, 9)* have associated chemical changes of this type with the "Maillard reaction," more generally known as the "browning reaction." The general explanation for the mechanism of nonenzymic browning[f] is that a chemical reaction occurs between compounds containing amino groups and free aldehyde groups *(6)*. The source of the aldehyde groups encountered in meat is glucose or its breakdown products; one of the primary constituents of the meat cells is amino compounds.

Various means have been used to prevent or retard browning in other dehydrated foods. Ayers and Stewart *(1)* reported on yeast fermentation for the removal of glucose from egg albumen before drying. They found yeast to be more suitable than bacteria and stated that the fermentation can be more readily controlled. Large scale trials by Carlin and Ayres *(3)* have shown yeast fermentation to be commercially feasible. Kline and Sonoda *(8)* stated that procedure using resting cells was refined to the point where glucose-free albumen powder could easily be made.

This investigation was undertaken to study the major factors contributing to browning in dehydrated pork. The objective was to develop a product with desirable organoleptic properties which would have extended shelf life.

Parallel studies conducted at the Missouri Station *(2)* have shown the volatile components of vacuum packed-stored dehydrated pork to be basic in nature, to exhibit reducing properties, and the total basicity and reducing power to increase with a rise in storage temperature. It was also shown that carbonyl compounds were present in all stored samples of dehydrated pork, and that the total mono-carbonyl content increased with elevated storage temperatures. Ammonia and acetaldehyde were positively identified as being present in the volatile fractions of vacuum packed-stored dehydrated pork. Qualitative organic analysis, paper chromatographic techniques, and absorption spectra measurements were used in the identification of the compounds.

## MATERIALS AND METHODS

The lean meat (95%) from fresh ham used in this investigation was passed through a ½-inch grinder plate. A portion was then ground through a ¼-inch and a second portion through a ⅛-inch plate. A portion of the ⅛-inch grind meat was further comminuted in a Waring blender for 3 minutes before it was exposed to the yeast cells. The ground meat was packaged, frozen at —10° F., and stored at 0° F.

Yeast cells *(Saccharomyces cerevisiae)* were obtained in one-pound cakes. The cells were suspended in distilled water, washed and centrifuged 3 times, then placed in yeast extract broth (pH 5.4) for 12 hours. The activated cells were again centrifuged and washed 3 times with physiological saline to remove the growth medium. One gram of compacted moist yeast cells was added for each 10 g. of meat. Conditioning the yeast cells in nutrient broth for 12 hours resulted in more rapid fermentation of the glucose when the cells were added to the meat.

Other methods of preparing the yeast were: washing the cells and conditioning them in a 1% glucose solution; adding the washed yeast cells to the meat without conditioning; and adding the unwashed suspended cells directly to the meat. Yeast concentrations studied were 1.7, 2.5, 5, 10, and 20% by weight of the meat to be fermented. Fermentation periods were 1, 2, 4, 8, and 16 hours at 40° F. The yeast cells were suspended in water equal to the weight of the meat before being made into a slurry with the meat. During the fermentation period the meat and yeast slurry was agitated with a low speed mechanical mixer.

The fermented meat was cooked in a steam jacketed kettle to coagulate the porteins and to drive off the excess moisture. The fermented cooked meat was then spread ¼-inch deep in small aluminum trays and dehydrated in an oven at 65° C. under 28 inches of vacuum for 10 to 12 hours. The dehydrated meat was sealed in glass jars under 26 inches of vacuum and stored at 120° F. for 2 months.

**Determination of glucose by the modified Hall-Somogyi method (5).** Ten grams of finely ground dehydrated pork and 30 ml. of distilled water were placed in a 50 ml. centrifuge tube and mixed. The tubes were placed in a boiling water bath for 5 minutes and the contents stirred frequently. The meat was centrifuged for 5 minutes and the supernatant decanted. The residue was washed twice with boiling distilled water, filtered and collected and made to volume.

One ml. of cadmium sulfate reagent was mixed well with 8 ml. of the meat extract. One ml. of 0.75 *N* NaOH was added

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[f] It is recognized that the term "browning" is broadly used. Several reactions leading to browning have been described or postulated.

slowly while mixing, followed by vigorous shaking. After standing a few minutes the contents were filtered through a dry quantitative filter. Two ml. of the cadmium-treated filtrate and 2 ml. of alkaline-copper-tartrate were pipetted into a Folin sugar tube. The tubes were placed in a boiling water bath for 15 minutes and then chilled. Two ml. of phosphomolybdic acid reagent were added and mixed well to completely dissolve the precipitate. The solution was diluted to 25 ml. with distilled water and the percent transmittance was read in an Evelyn Colorimeter using a No. 420 filter.

**Taste panel procedure.** To prepare the meat for tasting, 40 ml. of physiological saline were added to 20 g. of dehydrated pork and rehydrated for 12 hours at 40° F. The free liquid was filtered off and the reconstituted meat weighed to determine the amount of water absorbed. The meat was returned to the beaker, loosely covered, and heated for 50 minutes in a hot water bath at 80° C. prior to serving. A non-treated sample stored for the same period was used as a control for the taste panel. The panel consisted of 5 trained members who served throughout the study. The meat was presented hot, in individual trays, and each sample was scored for flavor, aroma, and texture.

## RESULTS AND DISCUSSION

**Effect of particle size on the fermentation rate of dehydrated pork.** The texture of the dehydrated meat became pasty and lost its pork flavor when prepared by comminuting the uncooked meat for 3 minutes in a Waring blender before it was fermented. The fat was not as evident in the blended sample as in the control, and the glucose content of the dehydrated sample was 0.032%. After 2 months storage at 120° F. the meat became slightly brown (Table 1). The fermented pork

**TABLE 1**

**Effect of particle size on the removal of glucose and the acceptability of yeast-treated dehydrated pork [1]**

| Raw meat particle grind | Yeast | Fermentation period hours | Glucose [2] | Taste panel remarks [3] |
|---|---|---|---|---|
| | % | | % | |
| Blended | 10 | 14 | 0.032 ± .003 | Bland flavor<br>Texture undesirable |
| ⅛ inch | 10 | 14 | 0.098 ± .006 | Slightly undesirable<br>Texture desirable |
| ½ inch | 10 | 14 | 0.130 ± .004 | Texture fibrous<br>Flavor undesirable |
| ⅛ inch control | 0 | 14 | 0.194 ± .008 | Very brown<br>Very undesirable |

[1] Meat fermented uncooked.
[2] Mean and standard error.
[3] Stored 2 months at 120° F.

prepared from the ⅛-inch grind retained a grey color during storage and was rated only slightly undesirable. Approximately 50% of the glucose was removed from particles of this size. The quantity of glucose removed was apparently influenced by the rate at which it was released from the meat cell. The diffusional barriers were decreased by finer grinding; hence, the quantity of glucose removed was increased. Particles of ½-inch grind did not ferment well since the glucose was not readily available to the yeast cells. Approximately 14% of the glucose was removed from the meat of ½-inch grind in 8 hours; nearly 38% was removed after 14 hours fermentation. The taste panel indicated that the pork ground through the ½-inch plate and then fermented had a poor texture. The flavor of this product, stored at 120° F. for 2 months, was characterized as *browned;* the texture was described as *fibrous and rubbery.* Meat of ⅛-inch grind was the most practical for microbial fermentation as judged by: (a) the amount of glucose removed and (b) the taste panel evaluation for color, texture and flavor of the stored meat.

**Effect of yeast concentration on rate of fermentation.** Dehydrated pork prepared in the laboratory as the control, contained from 0.17 to 0.19% glucose. The organoleptic criteria used to evaluate the desirability of each sample were flavor, aroma, and appearance. The unstored meat had a desirability score of 7.2 out of a possible score of 9, while the stored product scored 1.9. The stored meat was very brown and had a flavor similar to that of stale cooked meat.

Dehydrated pork containing yeast in concentrations ranging from 1.7 to 20% possessed a lowered glucose content (Table 2). The action of yeast in retarding

**TABLE 2**

**Effect of yeast concentration on the quality of glucose removed and product browning [1]**

| Yeast | Glucose | Browning score [2] | |
|---|---|---|---|
| | | Unstored | Stored |
| % | % | | |
| 20.0 | 0.078 | 4.8 | 6.2 |
| 10.0 | 0.096 | 5.2 | 5.5 |
| 5.0 | 0.094 | 6.8 | 5.0 |
| 2.5 | 0.131 | 5.0 | 4.2 |
| 1.7 | 0.125 | 5.8 | 4.6 |
| 0.0 | 0.180 | 7.0 | 1.9 |

[1] All treated samples were fermented four hours at 50° F. Each value represents an average of 5 samples.
[2] A score of 7 indicated the most palatable sample and the least amount of brown flavor.

brown flavor was found to be significant at the 1% level (Table 3). Length of fermentation period was found to influence the acceptability of the pork, but this influence was not as pronounced as that resulting from concentration of yeast. Fermenting the meat with from 5 to 20% yeast gave a product with a lower glucose content than either the control or those samples fermented with 1.7 to 2.5% yeast. Pork fermented with 1.7 and 2.5% yeast had a lower glucose content than the control, but this difference was not sufficient to prevent

**TABLE 3**

**Taste in panel evaluation for brown flavor, color and aroma in stored dehydrated pork fermented with yeast**

| Source | D/F | S.S. | M.S. | F-value |
|---|---|---|---|---|
| Judge | 3 | 14.0 | 4.6 | 5.19** |
| Time | 4 | 32.0 | 8.0 | 2.54 |
| Yeast | 4 | 98.0 | 24.2 | 7.68** |
| Time × Judge | 12 | 11.0 | 0.91 | 1.03 |
| Yeast × Judge | 12 | 30.0 | 2.50 | 2.82** |
| Yeast × Time | 16 | 50.5 | 3.15 | 3.56** |
| Error | 48 | 42.5 | 0.885 | |
| Total | 99 | | | |

** Significant at the 1% level.

browning. The greatest significant mean difference occurred in those samples fermented for 4 hours with 5% yeast or more (Table 4).

Freshly prepared dehydrated pork has a light grey color which changes to a dark brown during storage. This change is very characteristic of browning deterioration. Reducing the glucose content by yeast fer-

**TABLE 4**

**Browning scores as influenced by the length of the fermentation period and the yeast concentration**

| Yeast | Mean browning score [1] | Fermentation period hours | Mean browning score [1] |
|---|---|---|---|
| % | | | |
| Control | 1.9 | 0 | 1.9 |
| 1.7 | 3.8 | 1 | 3.7 |
| 2.5 | 3.4 | 2 | 4.5 |
| 5.0 | 4.7 | 4 | 5.3 |
| 10.0 | 5.3 | 8 | 5.1 |
| 20.0 | 6.1 | 16 | 4.9 |

[1] A score of 7 represents the most palatable sample and the least amount of brown flavor.

mentation was found to significantly reduce browning. All samples of dehydrated pork prepared by yeast fermentation were found to have less brown flavor and color than the control. The influence of the yeast was most pronounced in those samples containing 5% yeast or more. Yeast flavor was usually detected in pork fermented with 20% yeast, but only occasionally at the 10% level. Pork fermented with 2.5 and 1.7% yeast developed more browning in color and flavor during storage than the pork fermented with 10% yeast.

The interaction of length of fermentation with yeast concentration was found to have a significant influence on the quantity of glucose removed during the first 2 hours of the fermentation period. When the fermentation period was increased to 4 hours, the stability of the product was improved. Extending the period from 4 to 16 hours had some influence on the quantity of glucose removed, but the difference was not significant (at the .05 level). Prolonging the fermentation period lowered the glucose content but did not improve the desirability of the product.

**Studies on cooked fermented dehydrated pork.** Pork cooked in a small amount of water, cooled, then fermented with 10% yeast for 14 hours, was more stable after dehydration than uncooked, fermented pork. Cooking the meat before adding the yeast prevented the particles of meat from clinging to the mixing paddles, and also released more of the glucose to the yeast cells during the fermentation process. The cooked, fermented product had a desirable flavor and was superior in palatability to the control. Cooking the meat prior to fermentation destroyed many of the bacteria normally present in pork and minimized the development of undesirable odors and flavors. Fermentation of the uncooked meat reduced the glucose content by 50%, whereas, a 75% decrease occurred upon fermentation of the cooked meat. (Table 5).

**TABLE 5**

**Taste panel evaluation for browning of stored yeast fermented dehydrated pork [1]**

| Treatment | Appearance score | Aroma score | Flavor score [2] | Composite score [2] | Glucose [3] |
|---|---|---|---|---|---|
| | | | | | % |
| Uncooked | 6.2 | 6.2 | 5.4 | 5.9 ± 0.21 | .090 ± .005 |
| Cooked | 6.4 | 6.6 | 6.4 | 6.4 ± 0.26 | .048 ± .006 |
| Control | 2.0 | 2.6 | 2.4 | 2.3 ± 0.13 | .190 ± .008 |

[1] Samples were fermented with 10% yeast for 14 hours then stored at 120° F. for two months.
[2] Each value is an average of 5 samples.
[3] Mean and standard error.

## SUMMARY AND CONCLUSIONS

Washed yeast cells *(Saccharomyces cerevisiae)* were used with both fresh and cooked pork as a means of lowering the glucose content. Meat particles of ⅛-inch grind, fermented with 1.7 to 20% yeast, yielded a more stable product than the untreated meat. Approximately 50% of the glucose was removed in 14 hours with 5% yeast. Pork fermented with 5 and 10% yeast for a period of 4 hours gave the most desirable dehydrated product. Meat containing more than 10% yeast had a yeasty flavor. Fermenting the pork for more than 4 hours did not significantly improve the dehydrated product. The concentration of yeast had more influence on the palatability of the dehydrated meat than did the length of fermentation.

Off-flavors, caused by high bacterial populations in raw pork, were minimized by cooking meat prior to fermentation. Cooking the meat released more of the glucose to the broth thus making the sugar more readily available for fermentation.

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# Characteristics of Concentrates Made from Different Varieties of Citrus Fruits[a,b]

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**In Florida, many different varieties of citrus are used for the manufacture of frozen concentrates. Such products often have different characteristics depending upon the variety of fruit utilized. Characteristics of concentrates made from Hamlin, Pineapple, Valencia and Temple oranges, Duncan and Marsh grapefruit, and Dancy tangerine are discussed. The relationship between fruit variety and concentrate characteristics, such as flavor, color, vitamin C content, pectin content, occurrence of clarification and gelation and pectinesterase activity and its inactivation is discussed.**

Over 65 million gallons of frozen orange concentrate were produced in Florida during the 1953-54 season. The quality of these orange and other citrus concentrates was dependent upon the quality of the fruit available for processing. Many factors affect the quality of fruit; some of these are fruit variety and maturity, rootstock, cultural practices and rainfall.

Many varieties of citrus are grown and used in Florida. Camp *(4)* listed the Parson Brown and Hamlin as commercial early orange varieties; Pineapple, Homosassa, Jaffa, Seedlings and Temple as midseason varieties; and Valencia and Lue Gim Gong as late orange varieties. Various seedy varieties of grapefruit—such as the Walters, Silver Cluster, Duncan and Excelsior—are usually referred to as "Duncan." Marsh, a nearly seedless variety, and "Duncan" grapefruit are the principal types of grapefruit used in Florida for commercial concentrate production. Dancy tangerine is the principal variety of mandarin grown and processed. Camp *(4)* described the characteristics of these and other citrus fruits. Investigators *(7, 8, 9, 10, 26, 33, 34, 35)* have reported extensively on the acid, soluble solids and vitamin C contents, and on juice yield, color and flavor of juices extracted from the various varieties of citrus fruits used in Florida.

The quality of frozen citrus concentrates will be affected chiefly by the quality of the fruit, processing procedures, and storage conditions. Poor processing methods will ruin fresh citrus juices of excellent flavor, and improper storage conditions will result in deterioration of carefully prepared, good quality citrus concentrates. The principal purpose of this paper is to discuss the relationship between certain characteristics of citrus concentrates made from different varieties of citrus fruits grown in Florida. The citrus varieties to be discussed are the Hamlin, Pineapple, Valencia, and Temple oranges; Duncan, and Marsh grapefruit; and Dancy tangerine. The effect of fruit variety on the quality of citrus concentrates will be indicated by considering such characteristics as flavor, color, and vitamin C content, all of which are important to the consumer. Also to be discussed are the relationship between fruit variety and such characteristics of the concentrate as pectin content, pectinesterase activity, and clarification and gelation.

## CHARACTERISTICS OF CONCENTRATED CITRUS JUICES

**Flavor.** From the consumers' viewpoint, flavor is the most important characteristic of concentrated citrus juices. Since flavor can not be measured objectively, however, this property sometimes does not receive the attention that it deserves. The sweetness or tartness of a citrus juice is dependent upon the quantity and proportion of sugars and acids found in it. Rootstock, variety, maturity of the fruit, and cultural practices are some of the factors that affect the sugar and acid content of citrus juices and therefore, must also be considered as flavor factors. Data *(10, 35)* indicate that some of the early varieties of oranges, such as Hamlin, have a lower total soluble solids content and not as good flavor quality as midseason or late varieties. This is especially true if they are grown on rough lemon rootstock.

Aromatic constituents of importance to the flavor of citrus concentrates originate within the juice of the fruit and in the essential oils in the peel. Morgan, Veldhuis, Eskew and Phillips *(22)* have reported on a study of the properties of water-soluble flavoring materials (essence) recovered from Florida orange juices. Rice, Keller and Beavens *(27)* stressed the importance of peel oil as a flavoring constituent for California orange concentrate. The significance of peel oil to the flavor of concentrates was pointed out by Olsen, Huggart and Atkins *(25)*, who found that concentrate with a typical Temple flavor could be obtained only when cold-pressed peel oil from Temple oranges was added to the concentrate. Kesterson and Hendrickson *(19)* reported that essential oils expressed by the same procedure from different varieties of fruit varied very little in respect to their physical properties and ester content. However, they noted that the aldehyde content of cold-pressed oils of orange was highest when made from Valencia oranges and lowest when obtained from mixtures of Hamlin and Parson Brown varieties.

Off-flavors are undesirable in any food product and citrus concentrates are no exception. The development of undesirable flavors in concentrates may usually be attributed to fruit quality, processing procedures, or storage conditions. The use of immature, overmature, or stale fruit will result in products of poor flavor quality. Also, citrus fruits that are susceptible to the parasitic disease, black rot, caused by the fungus, *Alternaria citri* Ellis and Pierce, should not be used for the manufacture of frozen concentrate because their use will result in a product having an off-flavor and a high microorganism count. Hill *(12)* reported on this problem concerning the utilization of Jaffa oranges.

Excessive bitterness in grapefruit concentrate will result in consumer complaints. The chief cause of bitterness in grapefruit juice is the presence of the bitter glucoside, naringin. Kesterson and Hendrickson *(18)* found no significant difference in the amount of naringin in juices extracted from different

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varieties of Florida grapefruit. They established that most of the naringin was in the albedo, rag and pulp of the fruit. The modification of juice extraction and finishing procedures to prevent inclusion in grapefruit concentrate of large amounts of pulp, rag, and albedo will help to eliminate excessive bitterness from this product.

An undesirable "buttermilk" flavor may result in orange concentrate during processing as the result of bacterial growth as reported by Hays and Riester *(11)* and Murdock, Troy and Folinazzo *(23)*. Methods for the detection and thus the prevention of this type of spoilage have been suggested by Hill, Wenzel and Barreto *(13)*. Most citrus juices are susceptible to spoilage of this type. Heat treatment of citrus juices prior to concentration reduces the possibility of bacterial spoilage during evaporation and also improves the stability of the concentrate because of the inactivation of pectinesterase, the causative agent of clarification and gelation *(2, 40)*. If this heat treatment process is not carefully controlled and excessive and unnecessary heating occurs, flavor damage will be evident.

Changes in flavor may occur in frozen citrus concentrates during storage at temperatures below 0° F. Morgan *et al. (22)* pointed out a loss in aroma of orange concentrate to which water-soluble essence had been added, after storage for 6 months at 0° F. The occurrence of an undesirable flavor in citrus concentrates stored below 0° F., usually described as similar to the flavor of cardboard, castor oil or tallow, has been reported with increasing frequency during several past seasons. Unpublished results of investigations carried out at this Station support the hypothesis that these off-flavors are the result of oxidation of substances in citrus concentrates, such as peel oil, seed oil, lipids and proteins, and that oxidizing enzymes, such as citrus peroxidase, may also be involved.

Off-flavors in citrus concentrates occur more frequently and are more noticeable in those products that are made from juice having poor or only fair flavor intensity. Production of concentrates with high peel oil content is a good precautionary measure, since the flavor of peel oil tends to mask other less pronounced undesirable flavors. However, if possible, the cause of the off-flavor should be eliminated.

Utilization of Florida oranges has shown that processors prefer oranges of the midseason or late varieties for concentrate production because of their higher soluble solids content, better color, and flavor.

**Color.** Color is an important characteristic of citrus concentrates. The data reported by Huggart and Wenzel *(16)* indicate that juices from different varieties of citrus fruits are different in color. Their color measurements were made using the Hunter Color Difference Meter. As mentioned previously, juices from midseason or late varieties of oranges have a more desirable orange color than those from some of the early varieties. Visually, the Hamlin juice examined was predominantly yellow, whereas the Pineapple, Valencia and Temple juices were yellow-orange or orange in color.

Since orange concentrates in Florida are made from many varieties of fruit, a noticeable difference in the color of these products is evident. A more uniform color in orange concentrates through the processing season is desirable. Many processors blend Valencia concentrate, processed and frozen in bulk at the end of the Valencia season, with concentrate from early fruit varieties to improve both the color and flavor of products packed before midseason oranges become available for processing. Under existing standards *(37, 38)* tangerine juice cannot be added to Hamlin orange juice, either canned or concentrated, as a means of color and flavor improvement. However, blends of these two citrus juices have good color and flavor and are very acceptable.

**Vitamin C.** From a nutritional standpoint, the vitamin C content of citrus concentrates is of utmost importance to the consumer. Many reports may be found *(7, 10, 15, 20, 26, 32, 35)* concerning the ascorbic acid content of citrus juices and concentrates. As may be seen from data presented by Huggart, Harman, and Moore *(15)*, Hamlin orange concentrate is an excellent source of vitamin C and contains more of this constituent than the usually preferred Valencia orange concentrate. Grapefruit and tangerine concentrates contain less vitamin C than do concentrated orange juices. The percentage retention of vitamin C in citrus concentrates, after storage at different temperatures for one year, is shown to be very high.

**Composition.** There are many different types of subtances in concentrates, and many of them are important because they determine, as previously indicated, the chemical, physical, and organoleptic properties of these products. The composition of juices used for concentrate production determines to a large extent the changes that may take place in these products during processing and after storage.

Both clarification and gelation in citrus juices and concentrates are undesirable, and the problem has been discussed by many investigators *(6, 21, 36, 40)*. Data reported *(6, 21)* indicate that clarification and gelation will not occur in good quality citrus concentrates if they are properly stored at 0° F. or below, but that these changes do occur when storage temperatures are above 0° F. Concentrates made from the seedy varieties of citrus fruits, such as the Pineapple orange and Duncan grapefruit, are more susceptible to gelation than are those prepared from less seedy varieties *(40)*.

## DETERMINANTS OF CLARIFICATION AND GELATION

The pectinesterase activity and the pectin content of citrus concentrates determine to a large extent the rate and degree of clarification and gelation that occur in these products during either processing or storage. Data obtained by Rouse *(29)* during an investigation concerning the distribution of pectinesterase and total pectin in the component parts of citrus fruits indicate that the pectinesterase activity for the oranges and tangerine was highest in the juice sacs, with decreasing amounts being found in the rag, albedo, and juice, respectively. In the grapefruit varieties the albedo exhibited greater activity than the rag. Without exception the highest pectinesterase activity was found in the juice sacs and the least amount of activity in the juice. The amount of pectinesterase found in the juice sacs and rag of the oranges was higher than that found in the tangerine and grapefruit. The juice sacs of Pineapple oranges were very high in activity.

Reconstituted juices from 11 experimental packs of frozen tangerine concentrates were reported *(39)* to have pectinesterase activity ranging from 0.0004 to 0.0047 PE.u/g. of soluble solids and the amount of pectinesterase found *(25)* in 7 experimental packs of frozen Temple concentrate ranged from 0.0013 to 0.0076 units. Reconstituted orange concentrates from different varieties of fruit and containing different amounts of pulp have been reported *(1, 2, 30, 31)* with a range in activity from 0.0092 to 0.0572 units; also, in grapefruit concentrates a range of 0.0122 to 0.0380 units was found. Thus it is evident that the largest amounts of pectinesterase activity have been found in orange concentrates and the smallest amounts in concentrates made from tangerines.

As shown by Rouse *(29)*, total pectin on a wet basis was found to be highest in the albedo for the orange and tangerine varieties, but the rag had the greatest pectin content for the Duncan and Marsh grapefruit. The rag and albedo of Valencia orange contained a much higher pectin content compared to the other 6 varieties analyzed.

Since the juice sacs and rag, which are the chief insoluble constituents in citrus concentrates, have a high

pectinesterase activity and contain a large percentage of pectin, it is not surprising that Olsen, Huggart and Asbell *(24)* found that the tendency for clarification and gelation increased in citrus concentrates as the quantity of pulp was increased.

**Prevention.** Clarification and gelation in citrus concentrates may be prevented by inactivation of the pectinesterase in citrus juices by heat treatment of the juices either prior to concentration or between two of the stages during the evaporation process. Such procedures have been discussed by several investigators *(1, 2, 3, 17, 30, 31)*. Consideration of data presented by Atkins and Rouse *(1)* and Rouse and Atkins *(30, 31)* will show that the pH of citrus juices is more important than fruit variety in determining the time-temperature conditions for heat treatment necessary to inactivate most of the pectinesterase and thus produce a more stable product. Heat treatment is more effective for inactivation of the enzyme when the pH of a juice is low.

Cotton *et al. (5)*, Huggart *(14)* and Wenzel *et al. (40)* reported on the effect of degree of concentration of citrus concentrates on clarification and gelation in these products. At very high levels of concentration the stability of citrus concentrates to enzymic changes was increased; however, orange or grapefruit juices concentrated to approximately 30 or 40° Brix were less stable and more prone to clarify than some of the concentrates or single-strength juices having a lower soluble solids content. These observations were recently confirmed by Rice *et al. (28)*. It is also of interest to note that the effect of concentration on clarification in concentrated tangerine juice was different from that in the orange and grapefruit concentrates *(39)*.

## SUMMARY

The quality and characteristics of citrus concentrates produced in Florida are dependent upon many factors, such as rootstock, variety and maturity of fruit, cultural practices and processing procedures. Fruit variety has a direct influence on the flavor, color and vitamin C content of concentrated citrus juices. The occurrence and prevention of clarification and gelation in concentrates made from different varieties of fruit are discussed.

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# Ices Containing Chlorotetracycline in Experimental Fish Preservation

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**Methods of preparing flake-type and block ice containing added chlorotetracycline (CTC) are described. Relatively uniform distribution of CTC throughout ice blocks prepared by conventional slow-freezing procedures is attained by addition of carrageen (CG) preparations or carboxymethylcellulose (CMC) to the water used in its manufacture. Heating aqueous suspensions of CG in order to effect its solution may be avoided, at least with certain types, if the dry, finely powdered material is mixed with propylene glycol prior to mixing it with cold water. The ability of CG to effect dispersion of CTC throughout ice blocks is normally improved by the addition of both KCl and $CaCl_2$. Improved distribution of certain food colors, acridine dyes and aniline dyes in ice blocks is effected by addition of CMC or CG.**

**Bacterial spoilage of eviscerated fish is normally markedly delayed by icing them with flake or crushed block ice containing about 1 p.p.m. of CTC, rather than with ordinary ice, or by holding eviscerated or non-eviscerated fish at —2° C. in sea water containing from 1 to 4 p.p.m. of CTC. Experiments carried out on fishing boats and ashore show that failure to apply CTC ice promptly after fish are caught, a comparatively short period during which the fish are in contact with the ice, and poor icing procedures, all interfere seriously with the effectiveness of the ice.**

Previous reports have indicated the outstanding effects obtained with chlorotetracycline (CTC) in retarding bacterial spoilage of fish *(4, 11, 12)*. Recently these findings have been confirmed for fish and shrimp by Farber *(2)* and for shrimp by Idyll *(5)*. With shrimp, as with crab meat which also has a rather alkaline reaction, the concentration of CTC required for effective preservation is considerably higher than that normally found satisfactory for fish *(11)*. The work to be described was initiated in order to ascertain the value of CTC as a fresh fish preservative when applied under normal commercial conditions. It has involved the preparation of flake-type of ice containing the antibiotic, and has included the design of a method by which it can be distributed uniformly throughout blocks of ice prepared by customary slow-freezing procedures. These ices have been used to ice fish on commercial fishing vessels. Further tests concerning the effect of inclusion of CTC in refrigerated sea water on keeping quality of fish transported in this medium *(12)* have also been made.

## PREPARATION OF FLAKE-TYPE ICE

CTC was incorporated in the water used for preparation of ice made in a small "North Star" type of machine by the following procedure. Since the water used was hard (pH about 7.2), and the stock solution of the antibiotic was, for convenience, prepared only once daily, it was found necessary to add citric acid (200 p.p.m. final concentration) to adjust the pH of the 60 p.p.m. CTC solution to 3.5. Microbiological assays carried out by the "pad plate" method *(1)* showed that the antibiotic was relatively stable in solution at this pH value. In the unacidified water 70% of the antibacterial activity was destroyed in 24 hours at 20° C., and 100% in 24 hours at 25° C.

The stock antibiotic solution was prepared in a raised galvanized 300-lb. ice can which was coated inside with a corrosion-resistant and water-resistant rubber base paint. The citric acid and CTC were mixed conveniently by rapid introduction of the water by means of a perforated filling pipe situated at the base

of the tank. A plastic hose, the open end of which was covered by a fine mesh brass cloth screen, permitted liquid to flow by gravity from the bottom of this tank to an ordinary porcelain toilet tank via a simple ball-float valve. A constant "head" of liquid was thus maintained. The rate of flow of this solution from the bottom of the porcelain tank to the ice-making machine sump was adjusted to about 200 lb. per day by means of a needle valve which was carefully screened with brass cloth. The flow rate could also be adjusted by a slight raising or lowering of the porcelain tank.

Microbiological assays of ice prepared as above were made at intervals during the fishing season and have yielded the following results (p.p.m. CTC): 0.94, 1.4, 0.9, 1.3, 1.1, 0.86, 1.3, 1.5, 0.6, 0.7, 0.96, 1.3, 1.1. The average, 1.07, agrees fairly well with the expected value which is 1.25. Partial or complete melting of ice samples which occasionally occurred during their rather long shipment in ice to the laboratory may account for some of the rather low values.

## PREPARATION OF BLOCK ICE

A brief report describing preliminary experiments concerned with devising a method of distributing CTC throughout ice blocks which are slowly frozen has been published *(3)*. In ordinary aqueous solution crystalloids, unless present in eutectic concentration, and suspended solids tend to freeze into a central "core" *(9)* which is normally located near the bottom of ice blocks. Laboratory experiments were carried out by freezing 4-liter quantities of water in 9½ x 7 x 4 inch cans in still air at about —25° C. Three-hundred-pound blocks of ice were prepared under normal commercial conditions. The following "distributing agents" were employed: CMC (Hercules carboxymethylcellulose 70, high viscosity), carrageen (CG) 1 ("Seakem" type 5), CG 2 ("Seakem" type 9P), CG 3 ("Seakem" type 14), CG 4 ("Seakem" type 402), CG 5 ("Kraystay S"), CG 6 ("Kraystay T"), an alginate ("Dricoid"), a water-ice stabilizer ("Viscold") and "Difco" gelatin. Experiments with CG preparations 2, 3 and 4 indicated an effectiveness similar to CG 1 except in their response to added salts. CG 1 and CG 6 were identical in distribution effect upon addition of salts, CG 5 being somewhat less effective. In the figures most of the data are for CG 1 since the results obtained with it were representative of those found for other CG preparations.

In some experiments the CG preparations were brought into solution by heating 1% aqueous suspensions to 90° C. The following method proved more convenient for CG preparations 1 and 6: The dry powdered CG (100-mesh or finer) was mixed with twice its weight of propylene glycol, and was then made into a 5% paste with cold water. To this paste 0.5% of a surface active agent (e.g. "Sterox") was added to facilitate distribution. The resulting paste was added to the ice cans, preferably by means of a gear pump, and was then mixed with a strong jet of cold water, the CTC and inorganic salts being added during the filling procedure. In this procedure dry CG preparations which have no added potassium or calcium salt should be used, since the propylene glycol-aqueous gels cannot be dispersed properly in water if the salts are present. In most instances it is advisable to add both potassium and calcium salts to the CG preparations, for it has been found that these salts cause improved distribution of CTC. Certain CG preparations (e.g. CG 6) contain added KCl. CMC and alginate preparations were made into 1% solutions with cold water. Gelatin was dissolved in warm water.

**Sampling.** In initial experiments the small ice blocks were sampled by cutting them into 6 approximately equal portions with a hand-saw (Figure 1). Later, sampling of these was changed to conform with that used for the large blocks *(vide infra)*. Slices ¼-inch thick were taken from the 4 large surfaces (sample 1), and the remaining core was then sawn into three approximately equal segments; top, centre and bottom (samples 2, 3 and 4 respectively; Figure 3). Three-hundred-pound blocks were sampled by chipping ice to a depth of about 2 inches from representative localities on the four large surfaces. The blocks were then cut in half (longitudinally), and three further samples secured by chipping ice to a depth of about 2 inches from the freshly exposed surfaces of the top, centre and bottom pieces, keeping within a distance of 2 inches from each edge. In this last method sample 1 is by far the most crucial since it represents about 50% of the total volume of the blocks.

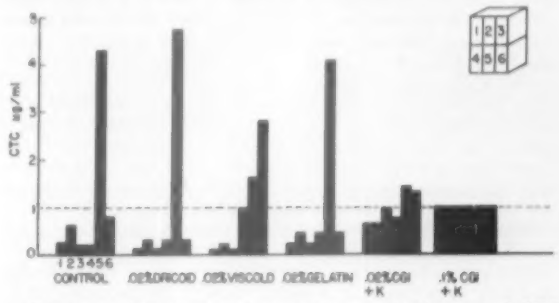


**Figure 1. Effect of various agents on distribution of CTC in small ice blocks.**

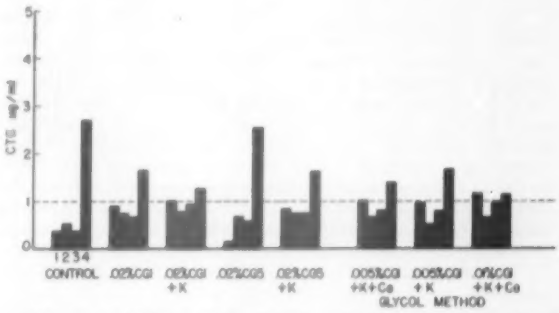


**Figure 2. Effect of CaCl, KCl, and the propylene glycol method on the distribution of CTC in commercial ice blocks.**

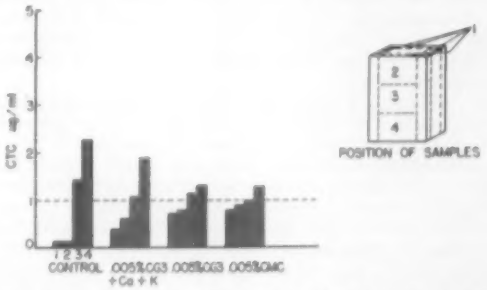


**Figure 3. Effect of CMC and of salts added to certain carrageens on the distribution of CTC in small ice blocks.**

## EFFECT OF VARIOUS "DISPERSING" AGENTS ON DISTRIBUTION OF CTC IN ICE BLOCKS

For economic reasons the lowest concentration of "dispersing" agent capable of causing a relatively uniform distribution of CTC (1 p.p.m.) in ice was sought. In initial tests with small blocks 0.1% CG 1 plus KCl (.01%) caused practically ideal distribution of CTC, while 0.02% was very effective. On the other hand the alginate preparations and gelatin were practically ineffective (Figure 1). Early tests with an old sample of CMC indicated that this was less effective than the carrageens *(3)*, but further tests with the new sample have indicated that this substance has excellent distributing properties *(vide infra)*. In further experiments the effect of several CG samples, with and without added KCl and $CaCl_2$ (each salt added in amount equivalent to 10% of dry gel weight), on distribution of CTC in commercial ice blocks was investigated. The propylene glycol method of introducing the CG was also studied. The results of

several typical experiments are shown in Figure 2. Without added KCl 0.02% of CG 1 caused a somewhat more uniform distribution of CTC than did CG 5. With added KCl (0.002%) both types were about equally effective in causing even distribution. The propylene glycol method of adding CG was quite effective. In the presence of KCl plus $CaCl_2$ 0.01% of CG was slightly more effective than 0.005%, but from a practical standpoint the lower level should prove adequate for ice which is subsequently crushed and mixed. In the absence of the added salts distribution was less uniform. In another experiment using small ice blocks it was found that 0.005% of CMC effected a uniformity of distribution of CTC which was identical with that occasioned by 0.005% of CG 1 plus KCl and $CaCl_2$. In the case of CG preparations 1, 5 and 6 addition of salts was necessary for maximum effectiveness, while the activity of CMC was not influenced by the addition of salts. With CG preparations 2, 3 and 4 addition of salts resulted in poorer distribution (Figure 3). These 3 types were not amenable to the propylene glycol method probably as a result of a higher natural concentration of inorganic salts.

## DISTRIBUTION OF SUBSTANCES OTHER THAN CTC

The general applicability of this method of distributing solutes throughout a large mass of ice which is frozen slowly was investigated. With sodium nitrite (0.1%), which has been used quite extensively as an inhibitor of spoilage of fresh fish *(10)*, 0.1% CG 1 failed to improve distribution. The distribution of certain common biological stains (Safranin Y, methylene blue and fluorescein, and the bacteriostatic acridine dyes "Trypaflavin" and "Rivanol") was definitely improved with 0.05% of CG as compared with that normally occurring in absence of a distributing agent. On the other hand there was a strong tendency for a precipitate containing some of the dye to accumulate at the bottom of the ice blocks. This layer is probably due to the precipitation of positively charged dye molecules with negatively charged CG particles *(6)*.

A number of tests were made with several recognized food colors using 0.05% of CMC as dispersing agent, since in several exploratory experiments this substance had given better results than the CG preparations. The results, using small blocks and the same sampling technique as shown in Figure 2 are given in Table 1. They show that the CMC effected a resonably even distribution of these colors which did not occur in ordinary aqueous solutions.

In conclusion, it is important to note that the final choice of a gel system for facilitating distribution of a given solute throughout an ice mass will depend on a number of factors as yet incompletely understood. These may include physical adsorption of the molecules of the solute upon the gel particles or an actual retardation of the rate of flow of the solute through the gel. The final selection of the best combination would have to be evolved for each solute. For CTC in concentrations of a few p.p.m., 0.005% of a suitable type CG, with added KCl and $CaCl_2$ incorporated by the propylene glycol method would appear economical. CMC has the advantage that it does *not* require added salts and is considerably cheaper than the CG preparations, but due to its viscosity it has to be added in a relatively low concentration (e.g. about 1%) to the water used in making ice. This means that 675 ml. of 1% CMC solution is required for a 300-lb. ice block, while only 135 ml. of propylene glycol—5% CG gel would be required.

## PRESERVATION OF TROLL-CAUGHT COHO SALMON WITH FLAKE-TYPE ICE CONTAINING CTC

The fish were caught off the west coast of Vancouver Island and were dressed and the kidneys removed in the usual manner, the visceral cavities being washed with sea water. Some fish were iced with ordinary crushed ice and others with flake ice prepared as previously described and containing approximately 1 p.p.m. of CTC. A number of fish were marked at certain intervals during fishing so that their *post-mortem* age was known at the time of sampling. The fish were weighed at the receiving plant after de-icing, and they were then iced again with the respective ices for shipment by truck to Vancouver. Several fish were selected at random and centre steaks about 1 inch thick cut from each under clean conditions. In most instances the steaks, wrapped in cellophane, were given an additional aging at 0, 4 or 10° C., since this procedure is considered to give valuable information regarding the potential keeping quality of the fish *(7)*. The results, given in detail in Table 2,

**TABLE 2**

**Comparative keeping quality of eviscerated coho salmon in ordinary ice and in flake ice containing approximately 1 p.p.m. CTC**

| Post-mortem age at time of sampling (days) | Aging procedure | Bacteria × $10^6$ per g. | |
|---|---|---|---|
| | | Ordinary ice | Chlorotetracycline ice |
| 3 | 24 hr. at 10° C. | 2.0 | 0 |
| 5 | | 3.8 | 0 |
| 8 | | 3.7 | 0 |
| 3-5 | 24 hr. at 10° C. | 2.2 | 0 |
| 7 | | 8.7 | 0 |
| 9 | | 17 | 0 |
| 12 | 20 hr. at 0° C. | 50 | 0 |
| 9 | 4 days at 4° C. | 56 | 0 |
| 12 | | 110 | 0 |
| 7 | 2 days at 10° C. | 20 | 0 |
| 9 | | 37 | 0 |
| 12 | | 55 | 0 |
| 12 | 24 hr. at 10° C. | 93 | 0.4 |
| 17 | None | 394 | 3.3 |

show that the CTC-containing ice caused a spectacular decrease in the rate of bacterial spoilage of the fish. In most instances a direct count of $<0.27 \times 10^6$ bacteria per g. was found with the CTC-iced fish. With a number of fish samples which had an initial count of 0 based on 10 microscopic fields, only about $0.27 \times 10^6$ bacteria per g. were found when 200 fields were counted. In all instances at a stage where the actual fish had become stale organoleptically, those stored in CTC-containing ice were still not appreciably spoiled.

The effect of crushed block ice prepared by the CG method, and which contained approximately 1 p.p.m. of CTC, on keeping quality of salmon under commercial conditions on salmon

**TABLE 1**

**Distribution of food colors in small ice blocks[1]**

| Color | Conc. (γ/ml.) used | λ (mμ) | Gel samples | | | | Controls | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| | | | Optical density | | | | Optical density | | | |
| Egg yellow | 5.0 | 434 | .131 | .145 | .113 | .105 | .010 | .030 | .336 | .357 |
| FDC orange No. 1 | 2.5 | 478 | .253 | .257 | .175 | .175 | .010 | .024 | .792 | .520 |
| FDC red No. 1 | 2.5 | 502 | .130 | .140 | .092 | .098 | .011 | .016 | .205 | .325 |
| FDC blue No. 1 | 2.5 | 635 | .400 | .350 | .315 | .300 | .017 | .038 | .462 | 1.15 |

[1] Hercules CMC-70-high and National Aniline food colors supplied by Harrisons and Crosfield (Canada) Ltd. Sampling method was the same as for small CTC-containing ice blocks. The optical density of melted ice was determined with a Beckman DU spectrophotometer.

packers and under laboratory conditions was investigated (Table 3). In the first experiment troll-caught coho salmon, which had apparently been dressed on the fishing boats and iced only on arrival at the fish camp, were studied. These fish had an uncertain history, but probably had a *post-mortem* age of 5-8 days when they were collected. They were iced with the experimental ices in the collecting packer. Usually this icing procedure used on fish packers is not very thorough since the fish are rarely on board for long. In this experiment they were about 1½ days on the packer before they were landed. A number of fish were sampled at random, and the centre steaks were stored at 4° C. for 4 days prior to making the bacterial counts. The results show that under these conditions, which permitted a relatively brief exposure to the CTC ice, only a slight and practically insignificant improvement in keeping quality was apparent.

In a further experiment round (non-eviscerated) seine-caught chum salmon of good quality were iced on a fish packer within 12 hours of capture. The fish were stored on the boat about 1½ days before they were landed. Three fish from each ice were eviscerated, repacked in their respective ices and stored in them for a further 10 days. Samples were taken from other fish and given accelerated aging for 4 days at 10° C. The results (Table 3) show that there was only a slight difference in keeping quality in the accelerated aging test, but that the fish stored for 12 days in the CTC ice were in much better condition than those stored in ordinary ice.

**TABLE 3**

**Comparative keeping quality of salmon stored in ordinary ice and in crushed block ice containing approximately 1 p.p.m. CTC**

| | Bacteria × $10^6$ per g.[1] | |
|---|---|---|
| | Ordinary ice | CTC ice |
| Experiment 1, Coho salmon | 423, 362, 206, 161<br>337, 317, 270, 298: $\bar{x}$ 298 | 206, 125, 189, 158<br>114, 156, 270: $\bar{x}$ 174 |
| Experiment 2, Chum salmon | 78, 64, 60, 54: $\bar{x}$ 64<br>74.5 (10 days in ice) | 17, 19, 25, 22: $\bar{x}$ 20.7<br>1.9 (10 days in CTC ice) |
| Experiment 3, Sockeye salmon | | |
| 9 days | 19 | 0 |
| 14 days | 242 | 2.1 |

[1] Each figure is the average for two fish.

A third test was made using round sockeye salmon in very good condition which had been collected shortly after capture and carried in ordinary ice for about one day on a fish packer. Several fish were selected at random, eviscerated, and the visceral cavities washed superficially with water. Four fish were iced in ordinary ice and four in crushed block ice containing about 1 p.p.m. of CTC. Two fish from each ice were examined after 9 days and 14 days in ice. The results (Table 3) show the greater effectiveness of the CTC ice than ordinary ice under these conditions.

The above three experiments reveal the limitations which apply to use of CTC ice in practice. Thus it is apparent that (a) a long interval *post mortem* before the antibiotic ice is applied, (b) too short an application, or (c) poor icing procedures all seriously interfere with its effectiveness.

## CTC IN REFRIGERATED SEA WATER

During the past few years renewed interest has been evidenced in the possibility of holding and transporting fish in mechanically refrigerated sea water at about —1 to —1.5° C., and the results of several previous experiments concerning the effectiveness of added CTC in retarding bacterial degradation of fish transported in this medium have been published *(12)*. To accumulate further and more extensive information regarding the value of this method several trials were made on a small fishing boat equipped with two refrigerated sea-water tanks, and which could ice fish simultaneously. Four separate experiments were conducted on this boat and the results are given in Tables 4 and 5. In the first experiment salmon were eviscerated at sea and treated in four ways as follows: (a) iced with ordinary crushed ice; (b) iced with crushed block ice containing approximately 1 p.p.m. of CTC; (c) held in refrigerated sea water at —1.5° C. and (d) held in refrigerated sea water containing 1 p.p.m. of CTC (calculated on the total volume of fish plus sea water). The fish were stored 8 days on the boat and, after landing, were sampled as usual and the samples aged 1 day at 10° C. The results (Table 4) showed that the treatments could be given the following order of preference when based on bacterial counts: refrigerated sea water plus CTC, ice plus CTC, ordinary ice and refrigerated sea water. The results with the refrigerated sea water alone were somewhat unexpected, since the fish in this medium were superior in appearance and firmness on arrival to

**TABLE 4**

**Comparative keeping quality of salmon in refrigerated seawater and in ice with and without added CTC**

| | Bacteria × $10^6$ per g. | |
|---|---|---|
| | Controls | Plus CTC |
| Experiment 1 | | |
| Coho (blueback) salmon in sea water (eviscerated) | 6.7 | 0 |
| | 16.7 | 0 |
| | 19.5 | 0 |
| | 2.8 | 0 |
| White spring salmon in sea water (eviscerated) | 1.0 | 0 |
| Coho (blueback) salmon in ice (eviscerated) | 5.6 | 0 |
| | 3.6 | 0 |
| | 4.5 | 0.8 |
| Experiment 2[1] | | |
| Chum salmon in sea water (eviscerated) | 16 | 0 |
| | 26 | 0 |
| | 28 | 0.27 |
| | 31 | 0.83 |
| | 44 | |
| | 45 | |
| Chum salmon in sea water (not eviscerated) | 11 | 0.27 |
| | 13 | 0.43 |
| Experiment 3[1] | | |
| Coho salmon in sea water (eviscerated) | 38.0 | 0.5 |
| | 51 | 5.8 |
| | 43 | 6.1 |
| Coho salmon in sea water (not eviscerated) | 17 | 1.1 |
| | 27 | 1.4 |
| | 30 | 1.6 |
| Experiment 4[1] | | |
| Grey cod in sea water (eviscerated) | 32 | 0.27 |
| | 43 | 0.41 |
| | 53 | 2.5 |
| Lemon flounder in sea water (not eviscerated) | 41 | 0 |
| | 51 | 0 |
| | 62 | 0 |

[1] Each figure is the average for two fish.

**TABLE 5**

**Viable bacteria and CTC in seawater in experiments 1-4**

| Experiment | CTC added (γ/ml.) | Seawater alone | Seawater + CTC | |
|---|---|---|---|---|
| | | Bacteria per ml. (× $10^6$) | Bacteria per ml. (× $10^6$) | CTC (γ/ml.) |
| 1 | 4 | .... | .... | 3.8 |
| 2 | 4 | 1.2 | 0.01 | 2.1 |
| 3 | 2 | 36 | 2.1 | 1.6 |
| 4 | 1 | 1.5 | 0.17 | 0.8 |

those stored in ordinary ice. However, the sea water, which was not changed for 8 days, was probably heavily contaminated with bacteria which grew on the fish samples during the accelerated storage period. This difficulty was also experienced in experiment 3 *(vide infra)*.

In the second experiment both eviscerated and round non-eviscerated chum salmon were stored 9 days in refrigerated sea water with and without added CTC, the fish eviscerated where necessary, and samples aged for 2 days at 4° C. The results are of special interest for they show that the CTC greatly improved the keeping quality of both eviscerated fish and fish which were not eviscerated for 9 days. In a further and rather similar test coho salmon were kept in both eviscerated and round condition in refrigerated sea water for 8 days. Samples were then taken and stored for 1 day at 10° C. The results again showed that the presence of CTC in the sea water greatly improved keeping quality of both round and eviscerated fish. In both experiments 2 and 3 the bacterial counts obtained with the round fish were, indeed, somewhat lower than with eviscerated fish. Experiment 4 showed that addition of CTC to refrigerated sea water caused a marked delay in the rate of bacterial spoilage of eviscerated gray cod and non-eviscerated lemon flounders.

In the above experiments the number of bacteria present in certain of the sea-water samples was determined by viable plate count using the following medium: "Difco" nutrient broth (0.8%), yeast extract (0.5%) of sea water (25%) and agar (1.5%). An incubation period of 7 days at 25° C. was used. The CTC content of the sea water was also determined by microbiological assay. The results (Table 5) show that there were considerably fewer viable bacteria in the sea water containing CTC, and that the antibiotic was relatively stable for days under the experimental conditions. In experiment 3 the sea water had a relatively high bacterial content and an unpleasant odor. The fish, however, were not seriously spoiled, and in canning gave a product which on inspection was conceded to be satisfactory. The amount of CTC added was always based on the calculated volume of a *full* tank (sea water plus fish), and since the actual amount of fish varied considerably in each experiment, the actual CTC content of the sea water alone at the commencement of the experiments could not be determined conveniently. In transporting fish on boats by this method it is essential to fill the tanks to avoid serious "splashing."

The use of CTC should be of great value in transporting fish in tanks containing refrigerated sea water, particularly since it can be used to advantage with fish which are not eviscerated. The tanks, pipes, etc. should be thoroughly cleaned between trips to prevent contamination of fresh sea water, and more particularly to avoid any possibility of creating a "CTC resistant" bacterial flora. In the present work the rather small tanks used have been adequately cleaned by simply washing them with clean water and then filling them with water containing 0.01% of the non-corrosive cationic detergent germicide alkyl dimethyl benzyl ammonium chloride. In former experiments this compound was found to exert a strong bactericidal action toward mixed marine bacteria *(8)*.

**Acknowledgments**

We are indebted to Mr. John Haining for designing the equipment for continuous addition of CTC solutions in the manufacture of flake ice. Our thanks are due to the B. C. Packers Ltd., The Canadian Fishing Co., and Mr. Martin of the Vancouver Ice Co., for providing facilities for the commercial experiments. The chlorotetracycline (Aureomycin hydrochloride) used was generously donated by Lederle Laboratories Division of the American Cyanamid Co., the CG samples by the Seaplant Chemical Corporation and Kraft Foods Ltd., and the carboxymethylcellulose and National food colors by Harrisons and Crosfield (Canada) Ltd.

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# The Reduction of Dehydroascorbic Acid by Foods Upon Being Heated[a]

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Early work of Delf *(2)* and LaMer, Campbell and Sherman *(10)* resulted in the general conclusion that vitamin C is labile to the temperatures used in processing canned foods. Experiments of Kohman *(6)*, Eddy and Kohman *(3)*, Kohman, Eddy and Carlsson *(7)* demonstrated that in the absence of oxygen, vitamin C is stable within the range of time and temperature used in the sterilization of canned fruits and vegetables.

Many have studied the oxidation of ascorbic acid. The almost universal conclusion seems to be that dehydroascorbic acid undergoes mutarotation as a result of rather prompt non-reversible opening of the lactone ring and formation of 2, 3-diketo-1-gulonic acid which no longer possesses antiscorbic value. Penny and Zilva *(12)* reported this reaction increased with pH and temperature. They maintained that when the conversion is complete, treatment with $H_2S$ yields an amount of ascorbic acid corresponding to about 10% of the original content of DA. If this is true, it emphasizes the point made below that no DA survives heat processing since the small increase in titration value sometimes encountered after $H_2S$ treatment may be due to a reconversion of the diketogulonic acid which has no vitamin C value. In our belief it more likely represents the DA produced during preparation of the sample for analysis.

A non-enzymic reduction of DA to ascorbic acid was indicated by Kohman *(8)* who, in 5 baby soups, each consisting of from 7 to 8 foods, found a 5 to 25% increase in ascorbic acid during processing (heat sterilization). By adding DA (ascorbic acid oxidized with iodine) the increase during processing amounted to 50 to 400%.

Wagner, Strong and Elvehjem *(13)* noted that: "Heat processing increases the capacity of corn to reduce the indophenol dye. It is questionable whether the increases are due to ascorbic acid." Goh *(4)* calls attention to a number of substances that tend to make the indophenol titration non-specific for ascorbic acid but adds that the effect of most of them can be minimized by a low pH.

## EXPERIMENTAL

It has been observed for a number of years that foods generally acquire a higher titration value of ascorbic acid as a result of heat sterilization in canning. This is as true of foods packed in glass as those packed in the tin can, and hence the phenomenon cannot be ascribed to nascent hydrogen generated on the metals. Time and temperature seem not to be specific since a small effect has been observed in the hot foods before canning. These foods similarly reduce methylene blue, which is regenerated upon exposure to air. Since Ball *(1)* has shown its oxidation-reduction potential to be on a similar level, it is not unreasonable to infer that DA is likewise reduced.

To explore the matter further the following mixture of foods was packed in a strained form in the glass jars commonly used for baby foods:

| Product | % |
|---|---|
| Lean Beef | 12 |
| Carrot | 8 |
| Sweet Potato | 9 |
| White Potato | 9 |
| Onion | 7 |
| Tomato | 10 |
| Semolina | 5 |
| Water | 39.4 |
| Salt | 0.6 |

The meat in this mixture, after being cooked, was converted to a slurry in a Waring blender. The vegetables were cooked in an appropriate amount of water to which the semolina was then added. After adding the slurry of meat, the mixture was passed through the fine screen of a cyclone.

DA was prepared by the method of Patterson *(11)*, which is stated to give a practically pure DA solution containing 100 mg. per ml. Varying amounts of this solution were added to portions of the prepared strained food to ascertain how efficient the reduction is. The strained food was then filled into baby food jars and processed 35 minutes at 240° F.

## RESULTS AND DISCUSSION

Following are the results (Table 1), the percent reduction of the added DA being based on the assumption that the DA solution contained 100 mg. per ml.[c]

In calculations, the 0.35 mg./100 g. DA, indicated as already in the strained food mixture by the $H_2S$ treatment, is included with the additions.

The question arose as to the fate of the unreduced DA. A preparation of the strained food mixture to which 0.6 ml. DA per 100 g. was added, was treated with $H_2S$ within an hour after processing and again after 24 hours, with the following results (Table 2).

The differences in values before and after $H_2S$ treatment are within the range of accuracy of the method and, together with

[a] The work reported was done at Campbell Soup Company, Camden, N. J.

[b] Currently in residence at Napoli, Italy (Societa Generale Conserve Cirio, San Giovanni a Teduccio).

[c] In making ascorbic acid determinations, we customarily dilute an entire jar or can with an equal volume of 1.5 percent oxalic acid. In case Waring blender treatment is necessary, an empty 400 ml. beaker is placed on the surface to avoid aeration by a vortex. The mixture is then centrifuged to obtain a clear supernatant liquid suitable for pipetting and titration. This introduces an error if the results are expressed as mg./100 g. because it disregards the valume of the insoluble solids, but the error cancels out in relative values in any given product. To determine DA $H_2S$ is bubbled through fritted glass for 2 hours through the supernatant liquid and then $N_2$ for 2 hours.

**TABLE 1**

| Addition | Treatment | Ascorbic Acid | Percent |
|---|---|---|---|
| | | mg./100 g. | reduced |
| None | Unprocessed | 4.00 | — |
| None | Treated with $H_2S$ | 4.35 | — |
| None | Processed | 4.35 | — |
| 0.1 ml.DA/100 g.[1] | Processed | 7.10 | 30 |
| 0.2 ml. DA/100 g. | Processed | 9.15 | 25 |
| 0.4 ml. DA/100 g. | Processed | 13.00 | 22 |
| 1.0 ml. DA/100 g. | Processed | 21.50 | 17 |

[1] In terms of DA these additions amounted respectively to 10, 20, 40 and 100 mg. DA.

other similar data, convince us that DA does not survive the heat process. The portion not reduced evidently undergoes non-reversible breakdown. Significant increases in titration value during heat sterilization when no DA is added is assumed to be the result of reduction of DA that is produced by oxidation of ascorbic acid during manipulation of the foods preparatory to canning.

The question arose as to whether or not the hydrogen sulfide evolved by foods might be significantly involved in the reduction of DA. The process used in sterilizing the strained food was 35 minutes at 240° F. For determining the hydrogen sulfide evolved by this mixture of foods, the method of Kohman *(9)* was used at a temperature of 240° F. for 35 minutes. This amounts to a more severe heat treatment than the process in jars since the heat penetration delay is not operative. In duplicate determinations, 300 g. samples yielded 7.2 and 6.9 mg. $BaSO_4$, which is equivalent to 2.3 mg. DA per 100 g. This is about 10% of the DA reduced when 60 mg. per 100 g. was added.

**TABLE 2**

| Procedure | Values |
|---|---|
| Without $H_2S$ teatment | 18.6 mg./100 g. |
| After $H_2S$ treatment, 1 hour after process | 19.0 mg./100 g. |
| Without $H_2S$ treatment, 24 hours later | 18.4 mg./100 g. |
| Same, after $H_2S$ treatment | 18.5 mg./100 g. |

Triplicate cans of a soup in which the garnish, consisting largely of diced vegetables and meat, occupied approximately half the volume of the can, were taken off the canning line after being closed and immediately cooled without being processed. Their average ascorbic acid content was 6.76 mg. per 100 g. Triplicate cans adjacent to the above on the line after being processed and cooled had an average ascorbic acid content of 8.51 mg. per 100 g.

To soup from the same batch to fill triplicate cans was added the DA obtained from ascorbic acid equivalent to 70 mg. per 100 g. After canning, processing and cooling, the soup then had 16.9 mg. ascorbic acid per 100 g., representing about a 12% reduction of the added DA or 14% if the increase without added DA is included.

This represents a less efficient reduction than was obtained from the homogenous strained food mixture, and it is logical that this should be so. The garnish in the soup constitutes roughly half the total volume; it is illogical to expect the DA solution to penetrate the discrete particles during the process to get the full benefit of their reducing potential.

Hewston, Fisher and Orent-Keiles *(5)*, as a result of a study of five canned fruit products high in sugar content, conclude that the Bessey-King indophenol method generally indicated biologically active ascorbic acid.

## CONCLUSION

The evidence presented should leave little doubt that the increase in titration value of foods with 2, 6-dichlorophenolindophenol after heat processing represents ascorbic acid, and as such, biological antiscorbutic value. But even the non-skeptic must admit there is precedent for an argument that it merely represents a chemical artifice and that the final conclusion must be based on a biological demonstration. Appropriate feeding experiments with guinea pigs have been inaugurated to establish the facts. Upon completion of the experiments, the results will be reported.

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# Theory and Application of Continuous Pressure Filtration to the Extraction of Irish Moss[a]

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**The operation and mechanics of continuous pressure filtration is described. After an extensive pressure leaf test program, the requirements for a continuous pressure filter installation were determined. A flow sheet for a proposed filter, taking into account these requirements, is presented and described.**

Irish moss *(Chondrus crispus)* is a seaweed which yields a hydrophilic colloid characterized by high viscosity and gel strength in aqueous dispersion. The colloid, called carrageenin, is a complex polysaccharide compound composed primarily of d-galacto-4-sulfate residues joined in the 1-3 position *(1)*.

Carrageenin, used extensively in the food industry, serves as an emulsion stabilizer in salad dressings and other oil-and-water emulsions, as a suspending agent in chocolate milk, and as a thickener in frostings and pie fillings. In large amounts, carrageenin custardizes milk to form puddings. It will modify the structure and growth of ice crystals in ice cream and sherbets. When used in fruit ripple sherbets, it gives them desirable melt-down characteristics. In the frozen fish and frozen fruit industries, a solution of carrageenin containing ascorbic acid may be used as a protective coating for the food during freezing and to reduce oxidation during storage. Carrageenin is also used as a stabilizer in pharmaceutical emulsions and as a binder in toothpaste.

Carrageenin is extracted from Irish moss with hot water. The extract is filtered to remove undissolved residue, then concentrated and dried. Processing presents problems common to the preparation of pectin, algin, and other colloidal gums.

The filtration step presents severe problems caused by high viscosity of the extract, gelatinous nature of the residue, and the necessity of producing a highly clarified filtered extract. The extract is quite dilute and further dilution to decrease viscosity is undesirable. An excessive amount of filter aid is required in batch filtration. This results in a large volume of filter cake which further complicates filtration problems. As the filter cake builds up during filtration, the flow rate decreases rapidly. Filtration cycles are relatively short and more than half of the cycle is down-time and wash-time. Filter aid costs are high and represent the largest single item in filtration costs.

Figure 1, a graph of a typical batch filtration rate plotted against time, shows the fast initial filtration rate which is rapidly reduced as the filter cake builds up.

Toward reducing filter aid costs, it was decided to investigate continuous rotary filters. Continuous removal of filter cake would permit filtration at the high rate characteristic of the beginning of a batch cycle.

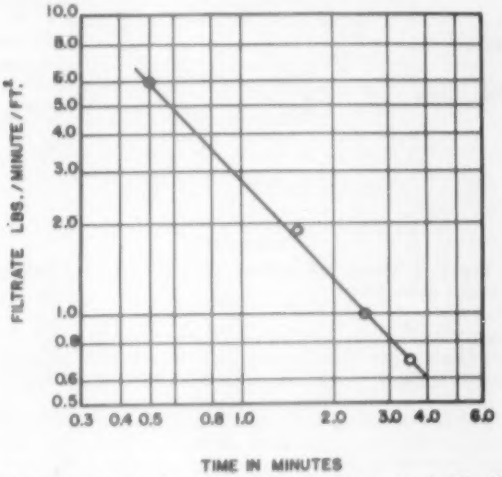


**Figure 1. Batch filtration of Irish moss extract filtration rate as a function of time.**

## OPERATION AND MECHANICS OF CONTINUOUS PRESSURE FILTRATION

The basic mechanism of continuous pressure filtration is illustrated in the simplified vertical section through a typical unit in Figure 2. The filter consists of a cylindrical drum rotated by a worm gear assembly, driven by a variable speed motor. The drum is housed in a pressure shell which also serves as a tank to hold the feed slurry. The drum deck is sectionalized into pan-shaped troughs parallel to the centerline with each section separated by caulking joints. Drainage screen, or gridwork, is fastened to each section, and the filter media is applied over the drainage grids and caulked at the caulking strips. As a section on the drum rotates through the feed slurry, the applied pressure forces the liquid through the filter media. Concurrently, the solids are retained on the media, forming a filter cake which continues to increase in thickness until the section rises out of the slurry. When the section rotates through the gas atmosphere, the applied pressure forces gas through the deposited solids which de-waters and dries the cake to a minimum liquid content. The rotation speed of the drum and its submergence in the feed slurry are such that a cake of sufficient thickness for proper continuous discharge is obtained, filtration rate is equal to the desired process flow rate to the filter, and the cake is sufficiently dried when it reaches the discharge point. Filtrate and gas, which pass through the filter media, travel through the internal piping of the filter to a valve mechanism described later.

As a section reaches the cake scraper blade, air or other gas is blown back through the internal piping and filter media to dislodge the solids. The scraper blade completes the cake dis-

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 28, 1954.

charge, and the cake falls continuously into a screw conveyor or other device for removal from the pressure shell. Thus the filter media is cleaned and the section again rotates through the slurry to repeat the cycle. By this method of operation, processing is continuous. A clean filter media constantly enters the feed slurry which, together with the thinner cakes and lack of

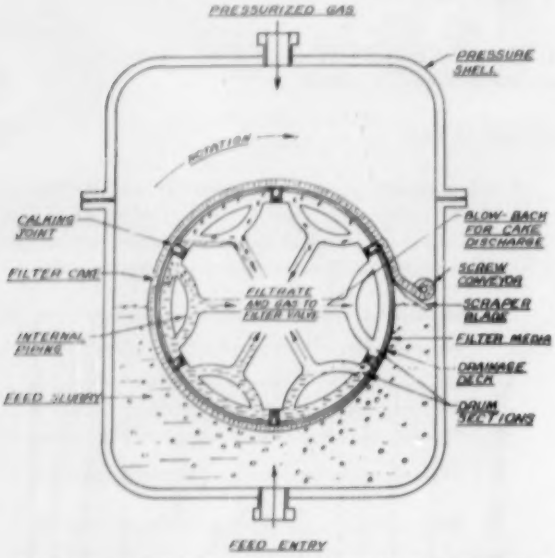


**Figure 2. Simplified vertical cross section of a continuous pressure drum filter.**

down time for cake-washing and press-cleaning, yields a considerably greater filtration rate per unit area of floor space over batch filtration. Manual labor is eliminated, and hold-up time in the filter is minimized.

The internal piping is shown in Figure 3. The main collection lines terminate in a concentric circle in a disc called the pipe plate mounted on the drum centerline. It should be noted that both leading and trailing edge piping on each section are used and should be employed where filtrate recovery is difficult and critical.

The filtrate and gas pass through the pipe plate and through a similar disc called the wear plate, bolted to the former. Thus the 2 plates rotate at the same r.p.m. as the drum. The wear plate has a lapped finish and makes a sliding contact with the lapped face of a filter valve. This latter part is stationary and separates the various phases of the filter cycle. It contains an annular ring which has the same inner and outer diameters as the internal piping outlets on the wear plate. Thus the filtrate and gas pass into the annular ring and are carried out through outlet ports on the other side of the valve.

The annular ring is divided into 3 distinct sections separated by adjustable bridge blocks whose surfaces are flush with the valve face. This construction permits the separation of the 3 phases of the continuous filter cycle. As the wear plate revolves slowly in close contact with the inner face of the valve-head, each hole connects in turn with the 3 segments of the annular ring thereby causing filtration, drying, and blow to be applied in correct sequence. Thus, all phases of the cycle are isolated, and continuous filtration and cake discharge are achieved.

Continuous vacuum filtration is primarily employed in all industries because of its lower initial cost. However, pressure drop is limited to a practical maximum of about 27 inches of mercury. By use of the higher pressure drops in continuous pressure filtration (up to 100 lbs./sq. in.) this type of filtration finds application in the following cases:

a. The employment of higher driving forces to obtain economical filtration rates on high-viscosity liquids or difficult filtering material.
b. Filtration of slurries with the liquid at or near the atmospheric boiling point.
c. Filtration of saturated liquids that would crystallize out or "set-up" when exposed to a vacuum and consequent vaporization.
d. The elimination of high labor costs encountered in many batch filtration applications where continuous vacuum filtration is not possible.

A pressure shell conforming to API-ASME codes is used to completely house the filter drum and a pressurized gas is fed at or near the top of the shell from a compressor. The slurry level in the shell must be controlled by an automatic level control device which permits the proper form and dry phases of the cycle. A high pressure blow is used for blow-back to dislodge the cake. The filtrate and gas exit through the filter valve at or slightly above atmospheric pressure and are passed to a filtrate receiver. If an inert gas is used, the overhead from the receiver may be recycled to the compressor to yield a closed gas system. The filtrate is withdrawn from the bottom of the receiver through a filtrate pump. The filter valve can be installed either inside or outside the pressure shell, with the former being preferred.

Figure 4 shows a pressure shell with head removed exposing the filter drum and showing the sectionalized construction. In this instance, the feed slurry is relatively fast-filtering, and the solids settle rapidly. Accordingly the drum is fed at the top with the pressurized gas admitted through the 2 ports below the flange. The pressure shell head is equipped with spray nozzles for washing the cake and cleaning the filter drum heads and shell upon shut-down.

Because the filter cake is continuously discharged in the pressure shell, some means must be employed for removing these solids to the atmosphere. The most common method is to include a screw conveyor and trough in the shell, into which the cake drops by gravity. The screw then conveys the solids to a cake receiver for solids collection. If the cake is a waste product and can be reslurried, water is added in the cake receiver and the slurry discharged through a level control valve on the bottom of the cake receiver. When a dry cake must be discharged, a

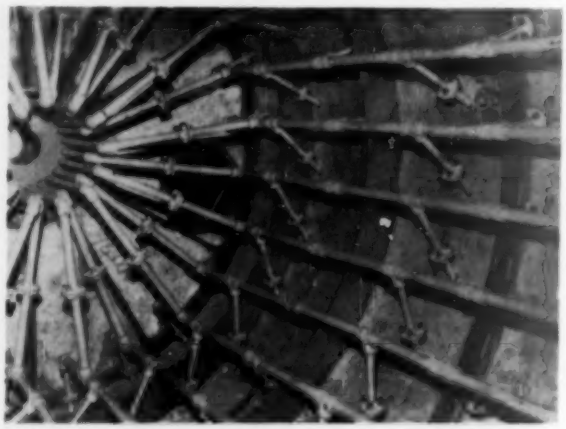

**Figure 3. Internal piping of pressure rotary filter.**

reversible screw conveyor with cake receivers on either end is used. The screw conveys the cake to one receiver until full, at which time the screw is reversed. A valve between the cake receiver and the pressure shell on the full receiver is closed while a similar valve on the empty receiver is opened to permit passage of solids. A screw conveyor at the bottom of the full receiver is turned on, and a second valve at the discharge of this conveyor opened to permit solids removal from the receiver. After solids discharge, the lower valve is closed and the upper valve opened to repeat the cycle as soon as the second receiver is full.

Continuous pressure filters can be built for operating pressures of at least 100 lbs./sq. in., although 40 lbs./sq. in. will generally be the maximum pressure required to obtain economical rates. Because of the greater initial cost of continuous pressure filters, continuous vacuum filters are generally preferred for most problems. However, there is a rapidly growing use of the former for handling volatile or high temperature slurries, or the

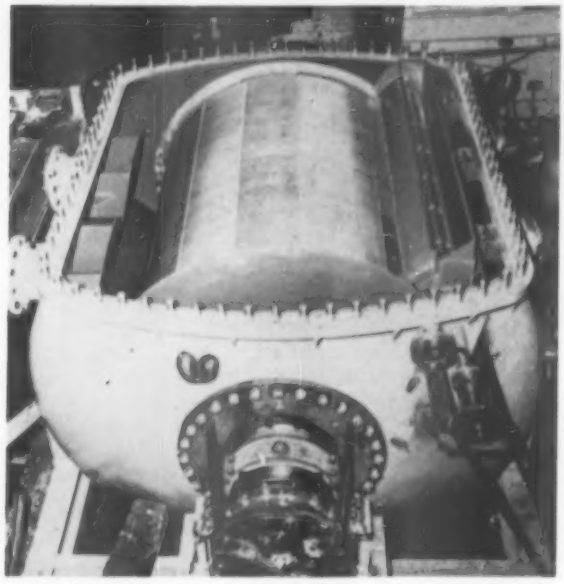

**Figure 4. Pressure rotary filter with head removed.**

filtration of high viscosity liquids such as Irish moss extract. Because of the greater investment, it is mandatory that sufficient preliminary testing or pilot plant work be done to completely establish filter design and flow sheet. If this is performed, initial cost can be minimized, and a very simple, or completely automatic operation, requiring a minimum of attention and maintenance, can be obtained on the full scale installation.

## PRESSURE LEAF TESTS

Since a pilot model of a continuous pressure rotary filter was not available, tests were conducted on a pressure leaf,[b] arranged so that the rotary cycle could be simulated. Figure 5 shows the leaf and pressure shell arrangements. Total capacity of the shell was about 4 liters. Area of the test leaf was 0.1 sq. ft. Tests were made in the following manner:

(a) Two liters of hot slurry with a measured amount of incorporated filter aid were placed in the shell; temperature was measured; cover bolted on.

(b) The shell was inverted so that the leaf was immersed in the slurry; pressure was applied from the high pressure nitrogen cylinder, through a standard welding regulator.

(c) The leaf remained immersed in the slurry under pressure for a period of time corresponding to the form time of a continuous rotary filter, i.e., the time that any increment of the drum would be immersed in the pool.

(d) The shell was then re-inverted and pressure maintained for a period of time corresponding to the dry time of a continuous rotary.

(e) Filtrate was collected in a graduated cylinder. The shell was opened; temperature of the slurry again measured.

(f) The cake was blown with a few pounds air pressure; appearance and ease of discharge of the cake were noted; a steam blow-back was employed to purge the filter media.

(g) During some runs nitrogen was passed from the filtrate graduate through a displacement gas meter, in order to provide data for sizing the air-compressor of a continuous pressure rotary.

Numerous synthetic filter media were tested, including Saran, Nylon, and Orlon. An Orlon cloth that gave the desired clarity was chosen, and a single sample of this cloth was used throughout a series of tests in order to gain information on cloth life and any tendency to "blind" with continued usage.

Tests were made with different form times and dry times. A short cycle was found to be desirable, as filtration rate fell off rapidly when the thickness of the gelatinous cake was increased. A 1.5 minute form time and a 1.5 minute dry time were established and used in most tests.

The cover of the shell was steam jacketed, and temperature variations during a test were small. However, temperature of the slurry varied between tests. In order to correlate the data at the temperature at which the filtration is actually performed in the plant, it was necessary to extrapolate the measured filtration rates to the plant operating temperature. For this reason, apparent viscosity versus temperature data were taken on all filtrates. Figure 6 shows typical viscosity curves. Filtration rates were extrapolated to the plant operating temperature (205° F.) by the relationship $V_{205} = V_t \sqrt{\frac{\mu_t}{\mu_{205}}}$.

(This relationship can be arrived at theoretically and was checked experimentally as shown in Figure 7.)

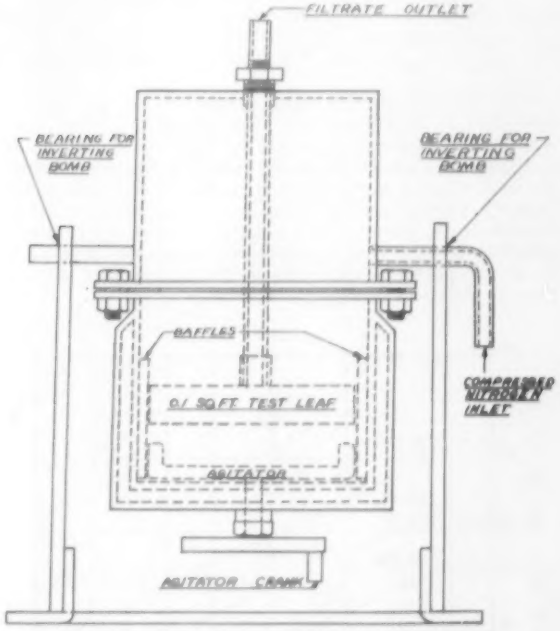


**Figure 5. Experimental pressure test leaf bomb.**

In Figure 7 the curves have parameters of cake pressure drop. A cross-plot of Pressure Drop versus Filtration Rate showed the effect of pressure to be greater than the theoretical square root value in some cases. We can only hypothesize that the physical mechanism of forming a cake under pressure may explain this departure from the theory. However, this factor, plus the desire to hold down the size of the production unit by maintaining maximum filtration rate per unit area, favored the highest pressure (40 p.s.i.) as a basis for design.

With the establishment of pressure, type filter media, form and dry cycle, and temperature correlation, an extensive study

[b] Designed by D. A. Dahlstrom and contructed in Eimco Corporation Laboratories, Palatine, Illinois.

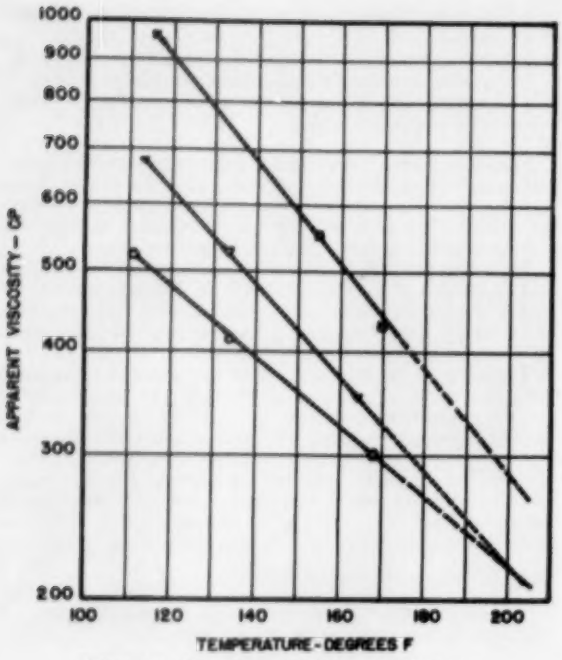


**Figure 6. Viscosity of Irish moss filtrate:**
□ **Run 6-10**
▽ **Run 11-15**
○ **Run 16-19**

of filter aid levels was undertaken. Figure 8 shows the effect of filter aid level on filtration rate. The dashed line (A-B) indicates the filtration rate chosen for the design of the continuous pressure rotary filter. The dotted line (C-D) shows the filter aid level required by the filtering equipment now used in the plant. It may be seen that the pressure rotary can be expected to perform the filtration with a filter aid consumption that is only 25% of the present consumption. Inasmuch as filter aid is by far the most important item in cost of filtration, this can mean an important saving in costs.

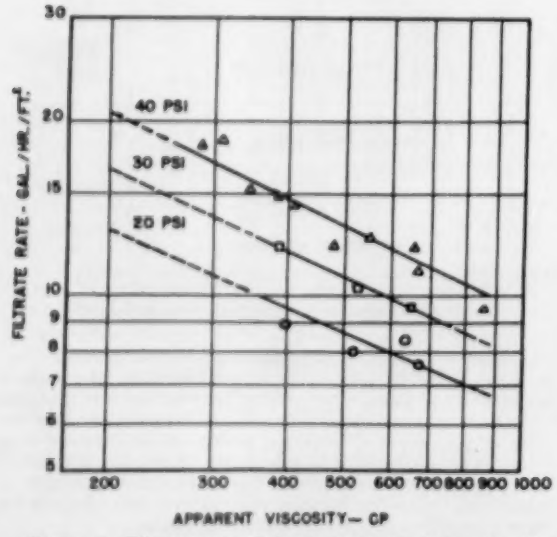


**Figure 7. Filtrate rate of Irish moss extract as a function of filtrate viscosity. Parameters of cake pressure drop.**

The curves in Figure 8 have parameters of moss particle size. The discovery that these curves intersect as they do, resolved an apparent anomaly that existed in the early stages of the investigation. The higher filter aid levels were not immediately investigated in these tests as they were of no interest on the pressure rotary filter. Consequently, all observations at the lower filter aid levels, led to the conclusion that coarse-grind moss was more easily filtered. On the other hand, the plant, operating at high filter aid levels, had observed the reverse relationship. These curves show that both observations can be correct. The explanation for the intersection of the curves probably lies in the fact that the coarse-grind moss presents less surface area per unit weight than the fine grind. Less filter aid is required, therefore, to completely coat the moss particles. Additional filter aid does not increase filtration rate, but may actually reduce the rate slightly by increasing the cake thickness.

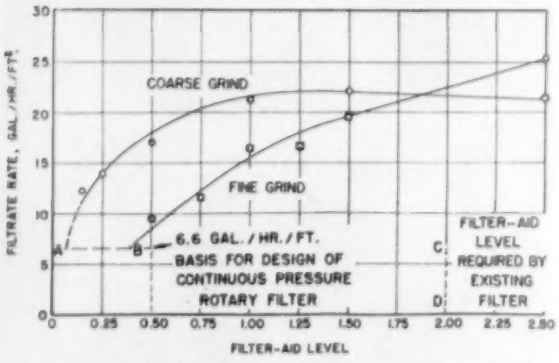


**Figure 8. Filtrate rate of Irish moss extract as a function of filter-aid level. Parameters of moss particle size.**

## PROPOSED CONTINUOUS PRESSURE FILTER STATION AND FLOW SHEET

From the extensive pressure leaf test program, the following requirements were found to be essential in the proposed continuous pressure filter installation:

1. Required operating temperature is 200-205° F.
2. Fifty per cent submergence of the filter drum with 3 m.p.r. is required as the probable average drum speed.
3. A special Orlon fabric is the optimum filter media which will yield both the desired filtrate clarity and filtration rate. However, if cloth life is too short because of the high operating temperatures, a very close weave Monel screen can be substituted at a higher initial cost.
4. No agitation of the feed slurry is required as the solids do not settle out upon standing.
5. Optimum operating pressure is 40 lbs./in.² gage. This requires designing for an operating pressure of 60 lbs./in.²
6. Feed level in the pressure shell should be automatically controlled to assure a relatively constant submergence of the drum.
7. Provisions should be made to blow-back with humid, hot air to prevent any gel formation on the filter media.
8. Spray washing of the cake is necessary to maximize extract recovery. Provision should also be

made for spray washing the drum heads and shell upon shut down.

9. All parts in contact with the slurry or filtrate should be of stainless steel to prevent corrosion or contamination.
10. The filter cake can be reslurried and discharged from a single cake receiver through a liquid level control valve.
11. Lead and trail pipes are required on each drum section because of the high viscosity of the liquid extract.
12. The pressurized gas should be maintained at 200-205° F. to prevent any cooling of the feed slurry, cake or filtrate. Upon cooling, a gel may be formed which might blind the filter media.
13. Air can be used as the pressurized gas medium.
14. High pressure air requirements can be minimized since a dry cake need not be discharged. The primary consideration is maximum recovery of clean extract. Thus, provision should be made for back-pressuring the dry phase of the cycle. This will minimize air requirements and still permit full pressure drop during the form phase of the cycle.
15. Because of the value of the extract liquor, a moisture trap as well as a receiver should be used to prevent any entrainment losses.

In order to achieve the above, the flow sheet shown in Figure 9 was devised. The filter is of stainless steel with operating pressure at 40 p.s.i.g. A stainless steel electrode assembly is used for automatic control of liquid level in the pressure shell. The Orlon fabric is specified although the caulking strips are wide enough to take the special Monel screen if this becomes necessary. No agitator is provided, but a drainage connection is included at the bottom for rapid discharge of the remaining slurry at shut-down. Any small accumulation of solids will be removed by this means. Two stainless steel wash headers with spray nozzles to yield an overlapping pattern will be employed for cake washing. In addition, sluice sprays are used for washing the drum heads, shell and scraper blade. All spray water is introduced at 200° F. All sections contain both trailing and leading internal piping which is oversized to permit good drainage. A safety relief valve is included on the pressure shell to permit any excess pressures to be relieved. The shell is also provided with two glass sight ports and internal lighting for easy inspection.

Referring to the flow sheet of Figure 9, the feed enters the filter shell through an electric flow valve controlled by the electrode liquid level controller. The "form" filtrate and gas pass to a stainless steel receiver, while the dry air and filtrate travel to a separate receiver. The overhead from this receiver is automatically back pressured to any desired level by an automatic pressure control valve. This permits the regulation of the amount of air used on the drying phase of the cycle. The downstream side of the valve passes to the moisture trap along with the overhead from the first filtrate receiver at approximately atmospheric pressure for recovery of any extract entrainment. The overhead from the moisture trap is vented to atmosphere. The second receiver underflow also has an automatic liquid level control valve which discharges to the underflow from the first

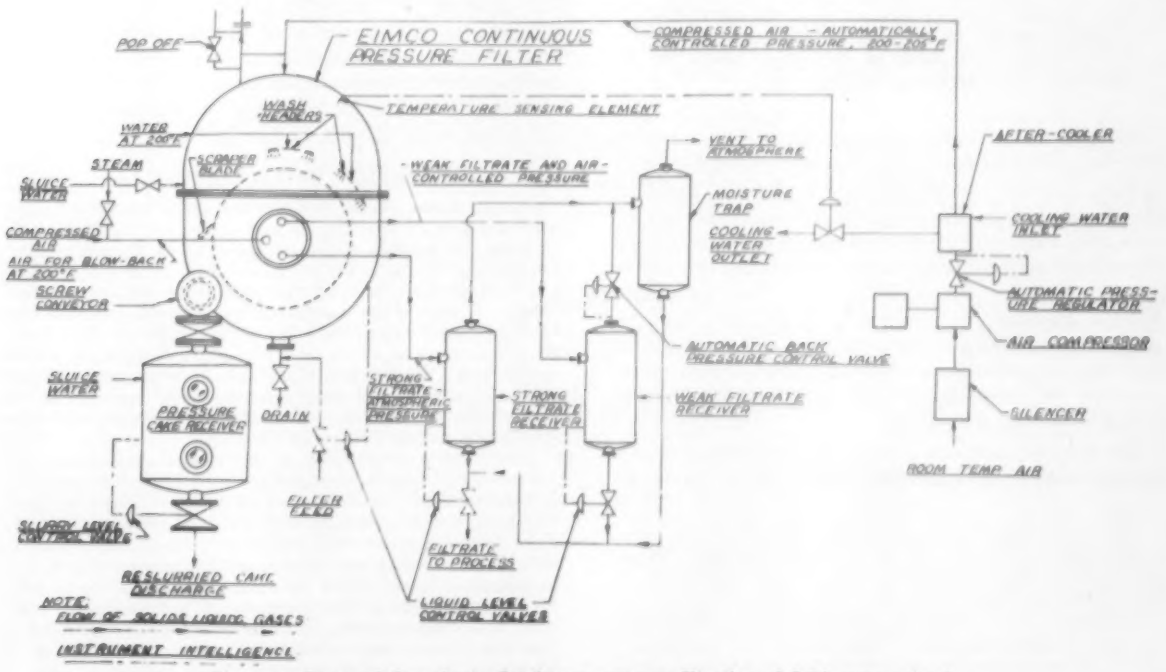


**Figure 9. Proposed flow sheet. Continuous pressure filtration of Irish moss extract.**

receiver. The moisture trap underflow likewise discharges to this point. A liquid level control valve on the first filtrate receiver delivers the product to further processing.

The discharged washed cake drops by gravity and sluicing to a uni-directional screw conveyor where it is reslurried and transported to a cake receiver. The slurry is discharged from the receiver through a slurry level control valve. An electrode assembly is used which actuates a solenoid valve to give a high-low liquid level control.

Room temperature air is drawn in through a silencer to the air compressor. The compressed air can be automatically controlled at any desired pressure level and passed to an after-cooler. Due to the adiabatic compression, the discharge temperature of the air will be above 205° F. Accordingly, the temperature of the air in the pressure shell is used as intelligence and controls the outlet flow valve for cooling water on the after-cooler. Therefore, a constant air temperature is always maintained regardless of the level of pressure or fluctuations in room temperature.

Blow-back air for cake discharge is obtained from the plant. Steam is blown into the air in order to heat it to 205° F. and to provide sufficient moisture to eliminate gel formation. If gel formation is severe, a direct steam blow can be used.

With the flow sheet specified, all 15 requirements stated earlier are provided for. Furthermore, operation is easy and completely automatic, yielding a continuous process with a minimum of hold-up, labor, and maintenance. The economy of filter aid saving, greater extract recovery, consistent quality, and minimum labor requirements are the primary economic advantages of the installation.

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# The Surface Darkening of Sliced Beets[a,b]

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**The surface blackening of sliced beets was reproduced in the laboratory and the course of its development followed by color measurements (Hunter Color Difference Meter). It is shown that an enzymatic reaction system is involved in darkening. Means of reducing surface darkening are suggested.**

The surface darkening of sliced beets occurs during processing when beets have been partially heated, peeled, sliced or cut and held and exposed to the air. Scalding conditions of time and temperature, size and age of beets, and holding time of the sliced or cut product are all factors directly related to this blackening. To a certain extent these discolorations have been overcome through variations in processing procedures, but the fundamental nature and causes of these color abnormalities have never been determined. The present study concerns the incidence of one type of discoloration known as surface darkening.

The purpose of this study was to reproduce the surface blackening on a laboratory scale and to follow its rate of development employing the Hunter Color Difference Meter *(9)*. Included in the study are beet center temperature data during scalding, and their relation to the blackening. A suitable procedure for measuring the development of surface darkening on sliced beets is reported as well as the effects of various chemicals on the development of such darkening.

## REVIEW OF LITERATURE

Various forms of discoloration in canned beets have been noted and grouped according to their appearance and occurrence. A white discoloration has been described by Stevenson *(16)*. However, darkening is the more common form of discoloration and has been observed in the raw state, after certain processing operations, and in the canned product. Discoloration in the fresh product is caused by a boron deficiency *(11, 17)*. "Purpling" has been described by Culpepper and Caldwell *(5)* in canned beets and Stevenson *(16)* mentions a discolored beet product resulting from the projection of the beets above the liquor. "Black beets," due to microbiological action, have been reported by several workers *(2, 10, 16)*.

Scott, Appleman and Wilson *(15)* studied sweet potato discoloration during preparation for processing and concluded that polyphenoloxidase (catechol oxidase) was the responsible agent. The amount of heat discoloration was dependent upon the activity of the enzyme. The only report found that refers to surface darkening of beets during processing operations is that of Stevenson *(16)*. His results indicated that if beets were insufficiently steamed, then sliced or cut, and allowed to stand some time before canning, a black discoloration would ensue. The discoloration was limited usually to the center portion of the slice or the inner part of the cut surface and did not occur if the beets were canned promptly. Stevenson postulated that

[a] The data published here are taken from a thesis presented by the senior author to the Faculty of the Graduate School, Cornell University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June, 1953.

[b] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, California, July 1, 1954.

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tyrosinase acted on tyrosine, present in beets, to change the amino acid to a dark colored compound.

This last report led the authors to investigate the surface darkening of sliced beets which occurs during certain processing operations when beets have been partially heated and exposed to the air during a holding period.

## SURFACE DARKENING

To clarify wherein surface darkening occurs during processing, a flow sheet, Figure 1, accompanied by some additional information concerning beet processing, is presented.

After washing, the beets are conveyed to scalders. Scalding provides heat and involves the use of from 0.25 to 5.0% lye to assist in the removal of the peel. Temperatures of from 160 to 240° F. (68 to 116° C.) are used, depending upon the processor and the size of the beets, but 210 to 212° F. (99 to 100° C.) is

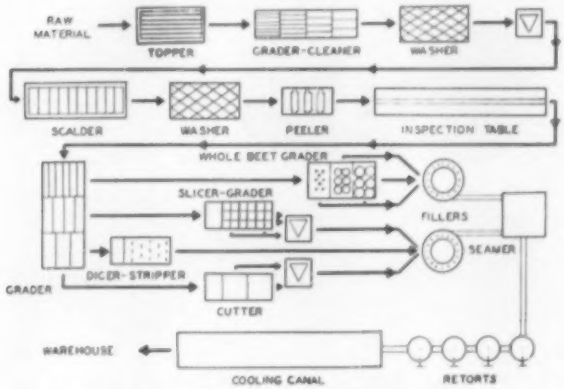



**Figure 1. Flow diagram for processing beets.**

the usual temperature. The time of scalding ranges from 12 to 40 minutes, depending on the size and age of the beet. The lye concentraiton and the scalding time are adjusted as the beet season progresses, both being increased.

The time of holding of the product in temporary storage (indicated by triangles after the slicer-grader and cutter in Figure 1) varies with the number of lines in operation, number and sizes of cans, and types of product. The holding times range from 30 to 90 minutes and it is at this stage that the surface darkening occurs. The darkening is observed primarily at the center of sliced, cut and quartered beets and frequently occurs over the entire surface. The holding times are more critical in small canning plants where the concurrent operations are limited.

## EXPERIMENTAL PROCEDURES

**Source and storage of raw material.** Detroit Dark Red Beets were employed throughout the studies reported here. One week after harvest, the 2½- to 4-inch beets were stored at 36° F. (2° C.) until used.

**Laboratory reproduction of surface darkening.** Two methods of reproducing the surface discoloration on beet slices were employed. The first method involved whole beets, whereas the second method was an immersion process accomplished by placing raw slices in boiling water for relatively short times.

Whole beets, 2½- to 2⅝-inches, washed and trimmed, were employed in all the experiments to insure general uniformity of shape and size. Slices, 5/16-inch thick, were obtained by means of a kitchen slicer, equipped with a stainless steel blade.

1. *Whole beet scalding procedure.* The scalding bath of distilled water was brought to 212° F. (100° C.) and a number of uniform beets added. Then at intervals of 10, 15, 20, and 30 minutes, a beet was removed, cooled, trimmed and sliced. The sliced beets were exposed to the air for approximately one hour at room temperature before observations were made and photographs taken.

2. *Immersion scalding procedure.* For rate of darkening studies, initial Hunter Color measurements were made on raw slices; these slices were subjected to a bath of boiling distilled water for various times, in seconds. A sliced beet was attached to a holder by means of 4 stainless steel prongs so that the slice was never allowed to rest on the bottom of the bath. After heating, the slices were exposed to the air for one hour at room temperature. In some instances, the slices were treated with various 1% chemical solutions before exposure. Afterwards, the slices were measured for reflectance and photographs were taken.

**Center temperature procedure.** An iron-constantan thermocouple was placed in each of three uniform beets. Zero time temperature readings were taken with a Leeds and Northrup hand potentiometer before placing the beets in a two liter beaker of boiling distilled water. Thermocouple readings were made every 5 minutes and at the time of removal from the bath. The beets were removed from the boiling water bath at 135° F. (57° C.), 150° F. (66° C.) and 165° F. (74° C.). The beets were then sliced and exposed to the air for 30, 60 and 90 minutes for comparison of the development of surface darkening.

**Color reflectance measurements.** The procedure for the use of the Hunter Color Difference Meter to obtain reflectance measurements of beet slices has been described *(4)*. Essentially, a plastic support (Plexiglass) was placed over the aperture of the instrument, to which the beet slices were added. The standard plate, supplied by the National Bureau of Standards for tomato color work *(14)*, was employed as the standard reference color. Small or large area of illumination was used depending upon the experiment.

1. *Heat treated sliced beets.* Raw beet slices were heat treated by the previously mentioned boiling water immersion technique for various times from 10 seconds up to 2 minutes. After one hour exposure to air, the slices were arranged arbitrarily by visual observation according to degrees of blackening. A visual score of 0 was assigned the slices with no darkening, whereas 100 indicated maximum blackening. The Hunter measurements were made in duplicate for each heat treated slice and averaged.

As a means of determining which one of the three averaged Hunter values correlated with visual darkening, the percentage change for each value was obtained by calculation from the individual reflectance readings. Thus a range of 5 units for $R_L$ (from 17.5 to 22.5) represented a 100% change; likewise ranges of 12 to 0 for $a_L$ and 2 to 0 for $b_L$ were considered to represent 100% changes. These percentage changes were plotted against the visual scores (Figure 4).

2. *Standard heat treatment for rate of darkening measurements.* Before rate of darkening measurements could be made on slices, it was necessary to establish a standard heat treatment. This was carried out in an experiment where the reflected color and residual "enzyme" (polyphenoloxidase) activity were determined at uniform intervals of time. From 48 raw beet slices, 12 were selected having $a_L$ values in the relatively narrow range of 9.8 to 13.3. The mean value was 11.15 ± 0.92, which formed the base zone in Figure 5.

Duplicate $a_L$ readings were made on the slices after they had stood for 60 minutes in air. To ascertain by reflectance changes the residual "enzyme" (polyphenoloxidase) activity of the initial heat treatment and air exposure a 1% solution of catechol was added uniformly to the surface of each slice. At the end of another hour's exposure to air, reflectance measurements were made again. The average $a_L$ values for both time sequences are shown graphically as Curves A and B in Figure 5. The immersion time of 40 seconds in boiling water was established as the standard heat treatment.

3. *Chemical agents on the rate of darkening.* The effect of chemical agents on the rate of darkening was studied using a standard heat treatment time of 40 seconds. For this purpose a selection was made from a number of halved raw slices, and those having a range of $a_L$ values from 20.5 to 21.2 were employed, using a small area of illumination.

After heat treating half slices in triplicate for 40 seconds, they were immediately placed in 1% chemical solutions for 2 minutes. The chemicals employed were sodium chloride, ascorbic acid,

Versene (ethylene diamine tetraacetic acid tetrasodium salt) and thiourea. Versene (Regular) was diluted with potassium acid phthalate buffer pH 5.5 to reduce its normal alkalinity which in itself would cause darkening of heat treated slices. The heated control samples were placed in distilled water for 2 minutes, and the raw control slices were held for an equivalent time in air.

Following absorption and penetration of the chemicals, the slices were exposed to the air at room temperature. Hunter a, measurements were obtained at 60, 90, 180, 270 and 360 minutes. Hunter readings were made for each of 3 half slices; the values were averaged and plotted as shown in Figure 6.

## RESULTS AND DISCUSSION

**Whole beets.** Slices from underscalded beets exposed to the air were found to darken readily in preliminary experiments. Fresh sliced beets did not appear to darken and after several hours exposure, became somewhat shriveled without apparent change in color. The larger the beet, the more heat and/or time was required to prevent blackening.

In Figure 2, one can observe the type of darkening involved in the present study. No darkening was observed in the use of the 0 and 30 minutes boiling times when whole beets were treated as described. After 10 minutes of boiling, large amounts of black pigment were observed after appropriate exposure, but at 20 minutes, only a slight amount. This evidence supports the contention that an enzymatic reaction is involved. The initial heating breaks down the tissues sufficiently to allow substrates and enzymes to come together. With more heat, the reaction is intensified, and with still more heat, the blackening reaction is prevented, probably due to enzyme inactivation.

One explanation for the surface darkening may be that of "thermal maceration" as previously described by Robinson, Moyer and Kertesz *(13)* as well as by Guerrant and Dutcher *(8)*. Greater losses of ascorbic acid resulted from limited heating and holding of peas and beans for 2 hours contrasted with higher blanching temperatures and shorter times.

In a preliminary report, Roberts *(12)* indicated that a disruptive effect on the continuous phase of the cytoplasm in tea leaves involved the inactivation of coenzymes required in the transfer of hydrogen from respiratory substrates to carriers of the cytochrome type. Polyphenols present in the vacuole then penetrate the cytoplasm to undergo irreversible oxidation by polyphenoloxidases. The resulting o-quinones form the various colored complexes often observed in postmortem darkening of plant tissues. He considered the effects of anesthetics, moderate heat, and mechanical damage involving shearing forces on the respiratory activity of vegetable tissues as essentially similar.

**Center temperature and blackening.** A number of experiments were carried out in order to prevent blackening on beet slices derived from whole beets. It was found that even reasonably uniform beets vary greatly with regard to heat penetration. An additional difficulty lay in the proper implacement of the thermocouple at the center of the beet. Center temperature data are reported in tabular form in Table 1, along with visual observations of darkening. The center temperatures were fairly uniform throughout the heating period, but beet No. 2 lagged by 10° F. (6.5° C.). In spite of the difficulties of beet variation and thermocouple implacement, certain general conclusions may be made. The beet removed at 135° F. (57° C.) exhibited considerable blackening around the edges of the slices indicating that the enzyme(s) had been activated by the heating but, on the other hand, the red center had not been activated for any darkening to develop. At 150° F. (66° C.) there was only a very slight blackening of the stele at the center of the slices after 30 to 60 minutes. The inactivation temperature for these whole beets would appear to be 165° F. (74° C.) based on a 90-minute exposure of their slices. The inactivation temperature results agree generally with Stevenson's report *(16)* of 150° to 180° F. (66° to 82° C.). It is pointd out that the above experiments are based on one size and age of beet only.

**TABLE 1**

**Beet center temperature measurements and darkening**

| Minutes in bath | Beet Thermocouple Readings ° F. | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 0 | 75 | 77 | 74 |
| 5 | 103 | 91 | 102 |
| 10 | 135 (out) | 126 | 138 |
| 15 | .... | 143 | 153 |
| 17.5 | .... | 150 (out) | .... |
| 19.0 | .... | .... | 165 (out) |

| Exposure minutes | Color of Slices after Exposure to Air | | |
|---|---|---|---|
| 30 | Black edges | Tints of dark on vascular tissue | No noticeable black areas |
| 60 | Black edges, Red center | Slightly dark vascular tissue, center | Slightly brown at stele, otherwise normal |
| 90 | Black edges Red center, 3-4 cm. diam. | Dark vascular tissue, center, 4 to 5 cm. diam. | Black stele only, otherwise normal |

Although no minimal temperatures for surface darkening activation were determined, it is interesting to note that Scott *et al. (15)* observed that a 140° F. (60° C.) temperature was required before the tyrosinasetyrosine reaction, responsible for this blackening, occurred on exposed sweet potatoes. The inactivation temperature was 194° F. (90° C.) for an exposure time of 5 minutes. In this connection, Bodine *et al. (1)* studying protyrosinase, observed that a temperature of 140° F. (60° C.) was reported to change the precursor into tyrosinase in grasshopper eggs. The question raised here is whether the surface darkening of beets occurs in a similar manner through activation of a proenzyme.

**Sliced beets and blackening.** In an effort to avoid both activated and inactivated portions of beet slices from scalded whole beets, raw beets were sliced and then immersed in boiling distilled water as described. The results of this approach are found in Figure 3, which portrays various degrees of darkening, the maximum in this series being a 60-second treatment. The blackening is fairly uniform over the entire beet slice surface, rather than exhibiting a red or black center as observed pre-

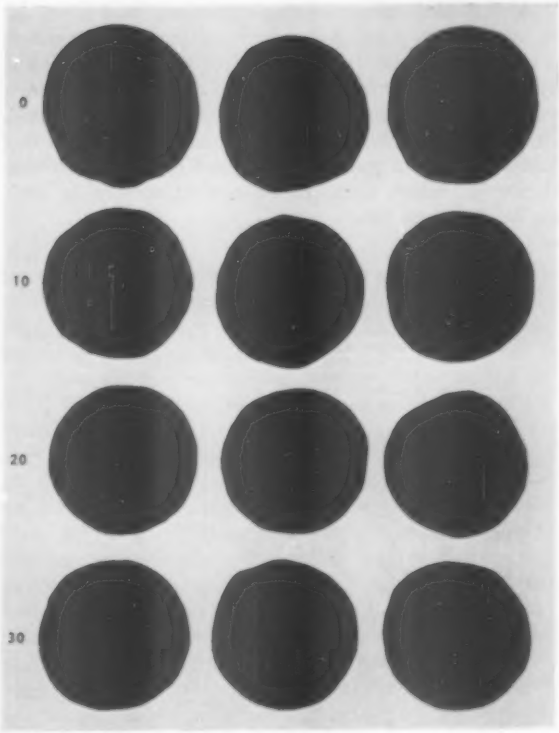



**Figure 2. Surface darkening of sliced beets after 0 to 30 minutes scalding.**

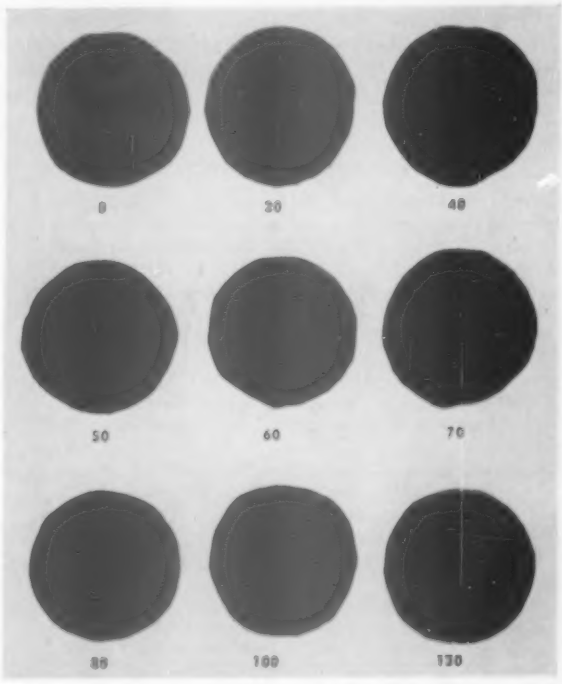



**Figure 3. Surface darkening of sliced beets treated in boiling water 0 to 120 seconds.**

viously (Figure 2 and Table 1). There is blackening for shorter and longer times of treatment; none at 0 and 120 seconds, again indicating that an enzymatic reaction is involved in the surface darkening of beets.

**Hunter reflectance measurements.** The use of the Hunter Color Difference Meter was considered feasible in a study of the rate of darkening of sliced beets as observed in Figure 3. The general position for the chromaticity of normal beet color is represented by a slight positive $b_L$ reading with a medium positive $a_L$ reading. From preliminary experiments a thickness of $\frac{5}{16}$-inch was found to be satisfactory for reflected color measurements and this was doublechecked by the so-called "back-up" method *(4)*. Either large or small area of illuminations were employed depending upon the experiment. The raw slice reflectance values indicated that both types of illumination could be used interchangeably and each type of illumination was reliable *(4)*.

**Reflected color measurements of heat treated sliced beets.** The incidence of darkening of heat-treated beet slices was determined by using the Hunter reflected color measurements as indices of discoloration. The effect of chemical inhibitors on the development of the black pigment was also studied in a similar manner.

The first experiment was carried out to determine which of the three Hunter values correlated with various degrees of visual darkening on sliced beets. As a means of determining which one of the Hunter values was the most important from a correlation standpoint, the percentage changes for each value was obtained by calculation as already indicated, and are shown graphically in Figure 4. The Hunter $a_L$ reflectance values correlate very well with visual scoring while other values do not. Therefore, the $a_L$ values provide a quantitative measurement of darkening. They are a measure of color saturation in the case of sliced beets exhibiting various degrees of darkening.

In establishing the standard heat treatment for later rate of darkening studies, one may observe in Figure 5 that at a 40-second immersion at 212° F. (100° C.), maximal darkening occurred with subsequent air exposure. Darkening increased rapidly with immersions from 0 to 40 seconds; and after this time decreased to the point where no blackening developed, as shown for the $a_L$ value of the 120-second treated slice. The slight discrepancies observed with the lower and higher immersion times were considered to be acceptable within the experimental method.

Apparently, increasing amounts of heat speeded up the reaction until a maximum was reached where further heating prevented darkening. The rapid rise in Curve A represented an activation of the blackening reaction and the descent indicated inactivation. These heating effects provided additional evidence that an enzymatic reaction was involved in the surface darkening of beets.

Curve B represents the $a_L$ values after the addition of catechol to the heat treated slices. The area between Curves A and B depicts residual enzyme activity, and

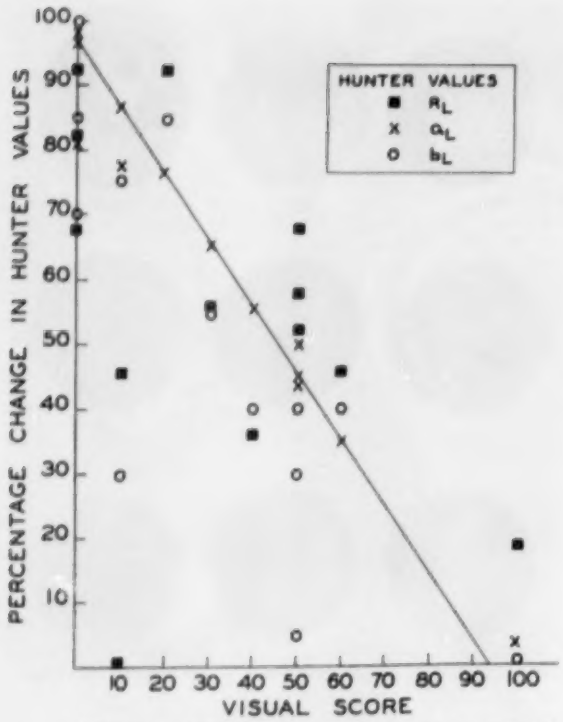



**Figure 4. Relationship of visual score to reflected color measurements.**

is a further substantiation of the fact that the darkening reaction is associated with such activity.

**The effect of chemical agents on the development of surface darkening.** Using a standard heat treatment of 40 seconds, and subjecting individual beet slices in triplicate to a variety of chemical solutions for 2 minutes as already described, and then exposing the slices to air for various time intervals, provided a means for following the development and inhibition of darkening on such slices with the Hunter Color Difference Meter. All the data are found in graphical form in Figure 6 where the Hunter $a_L$ values were plotted against surface darkening development time.

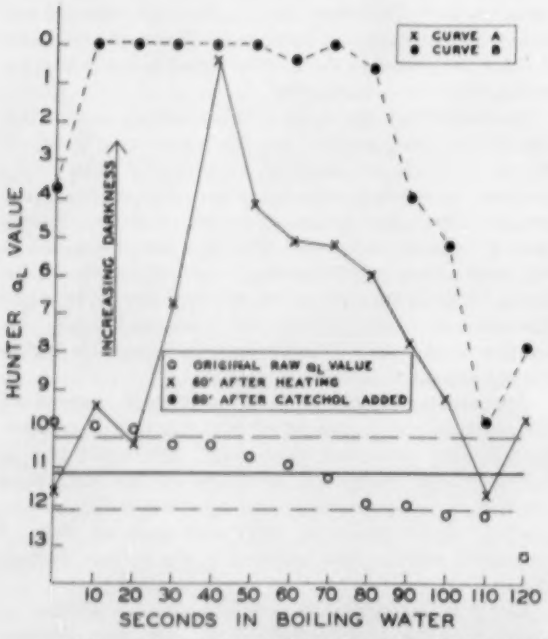



**Figure 5. Reflectance of heat-treated and air-exposed sliced beets.**

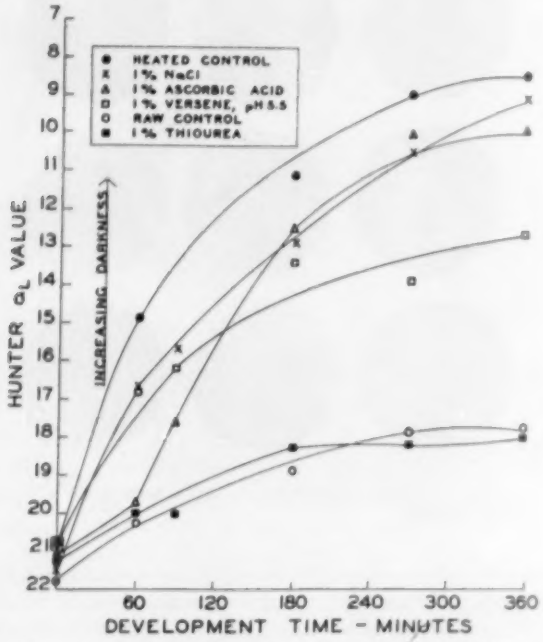
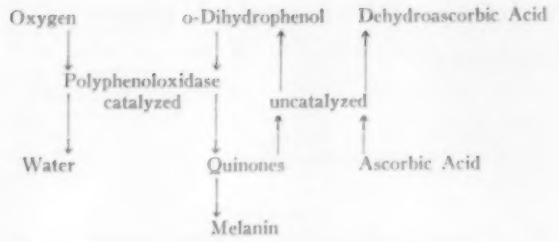



**Figure 6. Effect of chemicals on the rate of darkening.**

The 1% sodium chloride had only a slight depressing effect on surface darkening whereas 1% Versene was more effective. The 1% ascorbic acid solution prevented darkening during the first hour, and then darkening progressed in the same manner as in the heated control. Thiourea in 1% concentration gave values practically identical with those of the raw control. The percentage inhibitions at 360 minutes were calculated to be: 6.5 for sodium chloride, 15.0 for ascorbic acid, 45.1 for Versene, and 102.0 for thiourea.

Thiourea is widely known as a specific inhibitor for the enzyme polyphenoloxidase *(3, 6, 7)*, which is known to contain copper as the active site *(6)*. While thiourea is recognized as a general reducing agent, it also acts as a sequestering compound. The complete inhibition found here is probably a combination of the binding of the copper atoms of the enzyme as well as preventing the polymerization of quinones. Thus, the prevention of surface darkening in part is linked directly to the inactivation of a specific enzyme, polyphenoloxidase.

The initial inhibition by ascorbic acid is interesting. Ascorbic acid serves as hydrogen donor for the reduction of quinones that are being formed by oxidative enzyme systems.




As soon as the ascorbic acid is depleted, the quinones polymerize, forming black pigments known as melanins. Presumably the black pigment observed in the surface darkening phenomenon is melanin.

Sodium chloride was tested because it was known to retard fruit discoloration. It did not act to any great extent as an inhibitor of this darkening reaction. Versene was known to bind copper atoms through chelation to form stable complexes. It did not affect the initial rate of darkening, but rather, it gradually slowed down the reaction. The reasons why Versene was not more effective may be explained by lack of penetration and/or sub-optimal concentrations. It was concluded from the results of this experiment that a copper-containing oxidase is a responsible agent in the surface darkening of the heat-treated sliced beets.

Based on the results of this experiment, the treatment of held beet slices (and other beet products) with ascorbic acid should delay darkening in commercial operations. The times employed for the development of darkening in these experiments can be considered analogous to the holding times likely to be found in the commercial processing of sliced beets. Concentrations of ascorbic acid in excess of 1% would appear to delay the blackening for periods longer than one hour and therefore might prove technically feasible as a means of reducing surface darkening in processed sliced beets and other beet products which must be held exposed to air.

## SUMMARY

Successful laboratory procedures were developed for the reproduction of the surface darkening on sliced beets. Color photographs were taken of the various degrees of darkening to record a vivid description of the phenomenon. In center temperature studies of whole beets, a temperature of 165° F. (74° C.) was found to prevent darkening. This inactivation temperature was substantially in agreement with that mentioned in previous reports.

A method was established for measuring the incidence of surface darkening of sliced beets employing the Hunter Color Difference Meter. Raw beet slices treated in a boiling water bath showed that surface darkening was associated with an enzymatic reaction and that "thermal maceration" was possibly taking place. The effect of chemical agents including ascorbic acid on the rate of darkening further substantiated the contention that an enzymatic reaction was involved, and that their action interfered with a copper-containing oxidase.

Both scalding at 165° F. (74° C.) and the use of ascorbic acid were found to prevent this surface darkening of sliced beets.

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# Acetoglycerides—New Fat Products of Potential Value to the Food Industry[a]

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New fat and oil products having unique and potentially valuable properties can be produced by substituting, in effect, acetic acid for a portion of the fatty acids occurring in ordinary fats and oils so as to obtain predominately either diaceto triglycerides or monoaceto diglycerides or combinations of these. For the sake of simplicity these new products will hereafter be referred to as "acetoglycerides."

Acetic acid is a fatty acid but it does not occur as a glyceride in natural fats. Of the short chain fatty acids, butyric and caproic occur, mostly in milk fats, but only to the extent of about 2-4%. Edible fats and oils produced domestically are, with few exceptions, composed of mixed triglycerides in which the normal fatty acids containing 16 and 18 carbon atoms predominate. That is, the fatty acids combined as glycerides are mostly palmitic, stearic, oleic, and linoleic. The acetoglycerides are truly new-type fats.

On the basis of reports in the literature it appears that interest in acetoglycerides has been almost non-existent until relatively recently. Probably the first report is that of Normann *(20)*. In a patent concerned with the general interesterification of fatty acid esters he mentions an acetosteaerin product obtained by the reaction between tristearin and triacetin followed by fractional crystallization. This product and one derived from almond oil are grouped together and described as being tallowy to waxlike in nature. Jones *et al. (16)* prepared 1, 2-diaceto-3-palmitin and determined its melting point but apparently failed to recognize its peculiar characteristics. Within the last several years two groups of investigators, working independently, have developed practically all of the available information on acetoglycerides *(1-4, 7, 9-12, 14, 15, 18, 19, 22-24)*.

The object of the present article is to review the preparation and properties of acetoglycerides, discuss their status as edible products, and indicate a number of potential uses.

## PREPARATION

Acetoglyceride products can be conveniently prepared by two methods. One of these consists of a catalyzed interestification of a fat or oil with triacetin, either with or without the addition of free glycerol. The fat or oil used as starting material depends upon the properties desired in the finished product and can range from a completely hydrogenated fat to a liquid oil of relatively high iodine value. The proportion of glycerol used determines in some measure the hardness and melting point of the finished product, the higher the hydroxyl content the higher will be the melting point and the greater the hardness. Indeed, some potentially valuable acetoglyceride products consist essentially of monoaceto diglycerides. Because it is generally desirable to produce mixtures consisting, insofar as possible, of diaceto triglycerides or monoaceto diglycerides, or combinations of these, about six or more moles of triacetin per mole of fat are employed, while the proportion of glycerol is varied. The proportions of the various components present after interesterification can be calculated statistically by assuming that rearrangement is in a completely random fashion *(1, 8)*. Interesterification is brought about by adding to the reactants, after they have been freed of oxygen, moisture, and peroxides, about 0.3% by weight of sodium methoxide and then mixing the materials, while under nitrogen or hydrogen, for about 30 minutes at 50° C., or higher if the reactants are not liquid at this temperature. The catalyst is destroyed and the reaction stopped by adding a small amount of water or acid. The mono-, di-, and triacetins present are removed by low-pressure steam distillation.

In the second method for preparing acetoglyceride products, the fat to be used as starting material is first converted into monoglycerides, generally by mixing it with glycerol and about 0.1% of sodium hydroxide for 0.3-3 hours at 200-250° C. *(8)*. The resulting technical grade monoglyceride after being freed of uncombined glycerol is acetylated directly or is purified further and then acetylated *(10)*. The acetylation can consist simply of mixing the monoglyceride with the desired amount of acetic anhydride for about one hour at 110° C. followed by hydrolysis of the unreacted acetic anhydride for thirty minutes at 80° C. and then washing with water to remove the acetic acid which is formed.

After the preliminary purifications mentioned above, the acetoglyceride products must, like most edible fats and oils, be rendered bland in flavor and odor. This can be accomplished by the standard methods of alkali refining, bleaching, and steam deodorization *(11)*. The latter operation, which is really a high-temperature, low-pressure steam distillation to strip out odoriferous components and free fatty acids must be conducted under relatively mild conditions (at a temperature of about 175° C. and a pressure of 1 mm. of mercury). Under more drastic conditions any diglycerides present in the product will decompose extensively; and the diaceto triglycerides, which are more volatile than, for example, triolein, will distill away. The necessary purification can also be accomplished by actual steam distillation of the acetoglycerides, in those cases where the product consists of triglycerides *(2)*, or by molecular distillation.

## PHYSICAL PROPERTIES

The acetoglycerides owe most of their unique properties to their peculiar crystal habits. These can best be illustrated by comparing tristearin and 1, 3-distearin, which are ordinary glycerides, with the related acetostearins; namely, 1, 2-diaceto-3-stearin and 1-aceto-3-stearin.

The tristearin and distearin upon rapid cooling solidify in the alpha polymorphic form and then readily revert to the thermodynamically stable beta form on being kept at a temperature just below their melting points. In both polymorphic forms the tri- and distearin are opaque, hard, brittle solids. Changes in melting point accompanying their transformation are shown in Table 1.

Ordinary cooling of melted 1, 2-diaceto-3-stearin and 1-aceto-3-stearin produces the alpha form, which is quite stable; and most important, is extremely waxy *(22)*. The stability of this form increases greatly when small amounts of other glycerides, like mono- and tristearins are present as impurities *(3, 11, 22)*. Under ordinary conditions of preparation the acetostearin will remain waxy for years when kept at about room temperature. Cooling of the melted acetostearin to a temperature below about

[a] Presented at the Annual Meeting of the Institute of Food Technologists, Los Angeles, Calif., June 27-July 1, 1954.

[b] One of the laboratories of the Southern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

0° C. results in the transformation to the sub-alpha form which also is waxy *(15, 22)*. It is the waxy alpha and sub-alpha forms of the acetostearins and other acetoglycerides which have many potential uses.

The acetostearins can be obtained in the thermodynamically stable beta form by crystallization from solvents like hexane and acetone (see Table 1 for melting points), but in this form they have no unique waxiness and resemble the common glycerides.

**TABLE 1**
**Properties of some pure stearins [1]**

| Compound | Melting point, °C. | | Elongation [2] % | Appearance of alpha form |
|---|---|---|---|---|
| | Alpha form | Beta form | | |
| 1-Aceto-3-stearin | 47.5 | 49.1 | 640 | Waxy-opaque |
| 1, 2-Diaceto-3-stearin | 36.4 | 49.5 | >800 | Waxy-translucent |
| 1, 3-Distearin | 74 | 78.2 | *ca.* 0 | Glassy-opaque |
| Tristearin | 54.5 | 73.1 | *ca.* 0 | Glassy-opaque |

[1] Data on acetostearins determined by Vicknair *et al. (22)*.
[2] Elongation at break point of a strip measuring 3 x ¼ x 1/16 inches when stretched at a rate of 1.0 inch per minute at 22° C.

Photomicrographs of crystals of 1, 2-diaceto-3-stearin (Figure 1B) and 1-aceto-3-stearin (Figure 1C) obtained by cooling of their melts indicate that they are shaped differently from crystals of tristearin (Figure 1A) obtained in a similar manner. The acetostearins form an unordered network of interlocked ribbon-like crystals, while the tristearin crystals merge into a pattern of unordered fragments. Undoubtedly the interlocking of the soft, ribbon-like crystals of the acetostearins into a felt-like matrix contributes to the potential usefulness of these compounds and their homologs.

The ability of the acetostearins to function as soft coating materials has been measured to some extent by casting test strips of the compounds and stretching these at a uniform rate. The 1, 2-diaceto-3-stearin stretches more than does the 1-aceto-3-stearin, and both stretch much more than do ordinary fats *(22)*.

Fats and oils normally are mixtures of various glycerides and for economic reasons are invariably used as such. With acetoglycerides, a mixture also is advantageous for other reasons. As mentioned earlier, the presence of several glycerides improves crystal stability, so that the waxy alpha and sub-alpha forms are stable, for all practical purposes *(2, 10, 11)*. The acetoglycerides of fat-forming acids other than stearic resemble the acetostearins in waxiness but differ in the melting point. By taking advantage of this fact and preparing the correct mixture, it is possible to tailor, within limits, the properties of a specific product. It is also advantageous at times to use mixtures of diaceto triglycerides and monoaceto diglycerides. For example, the melting point of an acetoglyceride product made by acetylating a high-melting monoglyceride can be controlled by acetylating to different degrees (Figure 2). The presence of monostearin, tristearin, and similar glycerides in waxy mixtures can at times also be desirable. The range of physical properties which can be obtained by acetylating to various degrees each of several high-melting monoglycerides is indicated in Table 2.

Mixtures of acetoglycerides containing large proportions of acetostearins, which will hereafter be referred to as acetostearin products, have been subjected to physical tests to establish quantitatively additional properties of importance for commercial utilization. Among these is the permeability of films of acetostearin products to moisture *(18)*. Permeability per unit of film thickness has been found to vary about sixfold, depending upon the composition of the product (ratio of di- to tri-glycerides and liquid components), the total thickness of the film, temperature, and relative humidities under which the tests are made. The permeability of the better acetostearin films was less than that of cellulose acetate and only slightly greater than that of nylon, ethyl cellulose, polystyrene, and soft vulcanized rubber. Polyethylene and paraffin wax have permeabilities equal to 1/100 or less of those found for acetostearin products. It can be concluded that while the latter possess some permeability to moisture they would still be suitable moisture barriers for a large number of products.

Mixtures of acetoglycerides containing large proportions of aceto-oleins, which will hereafter be referred to as aceto-olein products, are waxy solids at temperatures in the range of —50° C. Therefore, their use as waxy coating materials is severely limited. Potentially the aceto-olein products are useful as low-melting oils or oils possessing a large amount of plasticity at low temperatures. The properties of several aceto-olein products prepared by converting commercial oleic acid or a natural oil into glycerol-free monoglycerides and then acetylating these *(9)* are recorded in Table 3. The acetyl content for two of the products listed is about 19%, while that for the other two products is about 14%.

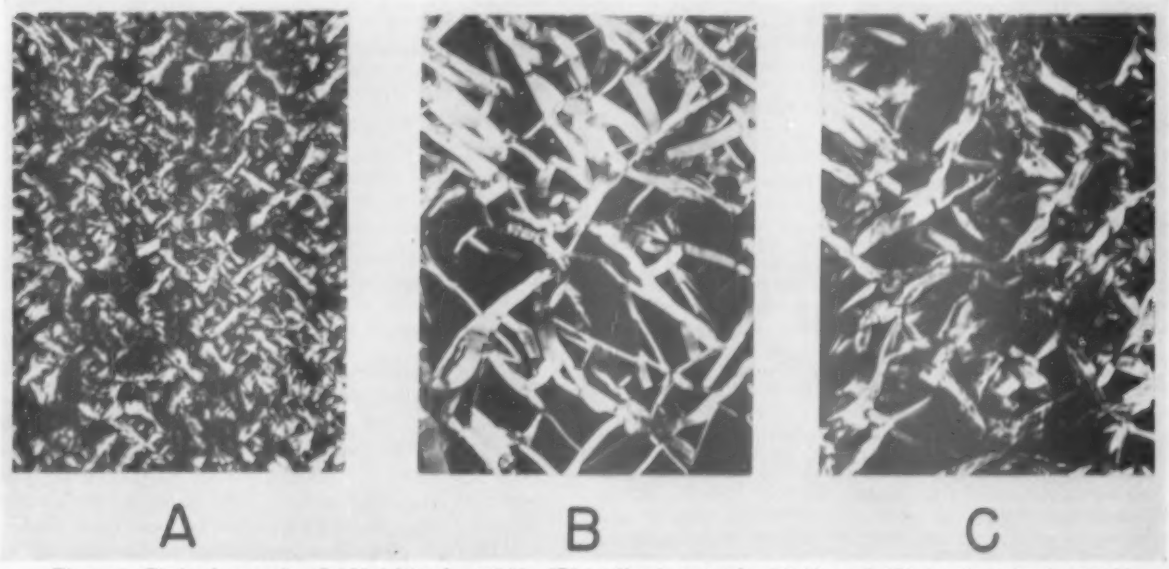


**Figure 1. Photomicrographs of (A) tristearin, 405 ×; (B) 1,2-diaceto-3-stearin, 150 ×; and (C) 1-aceto-3-stearin, 150 ×. Crystals formed by cooling to room temperature a drop of themelt on a slide.**

**TABLE 2**
**Properties of acetostearin products obtained by acetylation of monostearins (10)**

| Monostearin used | Product No. | Melting range, °C. | Hydroxyl value | Monoglyceride content, % | Elongation[1] % | Maximum load[2] lb. |
|---|---|---|---|---|---|---|
| 1-Monostearin | 1 | 45.0-48.0 | 153 | 17.8 | >800 | 1.70 |
| | 2 | 39.5-42.0 | 78 | 2.7 | >800 | 0.71 |
| | 3 | 38.0-39.0 | 36 | 0.3 | >800 | 0.49 |
| Commercial, molecularly distilled product, 94.5% monoester | 4 | 41.0-44.0 | 166 | 11.4 | 467 | 1.60 |
| | 5 | 32.0-35.5 | 78 | 2.8 | 513 | 0.43 |
| | 6 | 29.0-31.0 | 56 | 0.9 | >800 | 0.32 |
| Technical grade product from completely hydrogenated cottonseed oil, 61.0% monoester | 7 | 44.0-54.0 | 122 | 14.1 | 31 | 9.8 |
| | 8 | 38.0-54.0 | 84 | 4.9 | 241 | 6.7 |
| | 9 | 35.0-54.0 | 38 | 0.4 | >800 | 1.6 |
| Commercial, molecularly distilled product | | | | 91.5 | 4 | 3.7 |
| Paraffin | | | | ..... | 5 | 8.0 |

[1] Elongation at break point of a strip measuring 3 x ¾ x ¾ inches when stretched at a rate of 1.0 inch per minute at 22° C.
[2] Maximum load necessary to maintain stretching rate in elongation test. Values are an indication of strength.

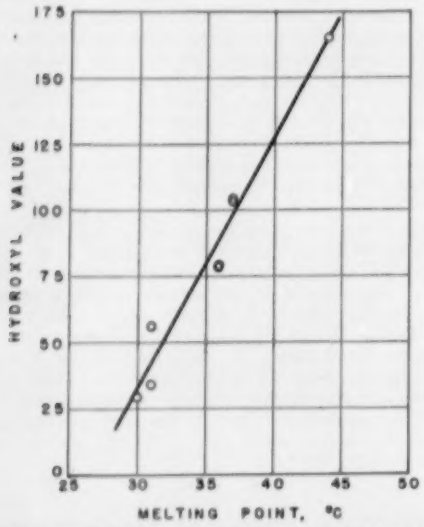


**Figure 2. Relationship between melting point and hydroxyl value of acetostearins made by acetylating a commercial, molecularly distilled monostearin.**

## CHEMICAL PROPERTIES

On storing liquid acetoglycerides in contact with water, hydrolysis occurs as with natural oils. The rate of hydrolysis is about the same as that for natural oils having the same content of free, fat-forming acids. In one series of experiments a liquid acetostearin product stored at 40° C. in stoppered Erlenmeyer flasks and in contact with air and water developed free fatty acids at a faster rate than did cottonseed oil during the first 35 days after which the free fatty acids in the cottonseed oil increased at a faster rate. Baur *(1)* in experiments of a different type stored acetoglycerides in the form of shortenings and as liquid base stocks for shortenings at temperatures up to 100° F. (38° C.) for one month. No evidence of acetic acid odor or flavor was observed after this storage. He stated flavor development to be typical of the original base oil or fat.

As would be expected, the oxidative stability of acetostearin products is very great, particularly if they are derived from completely hydrogenated vegetable oils which contain some natural antioxidants. A product derived from completely hydrogenated cottonseed oil (iodine value less than 1) and having a hydroxyl value of about 50 will not develop peroxides on being aerated for 1000 hours at 97.7° C. Aceto-olein products are, of course, less resistant to oxidation; but because of their lower iodine values, are more stable than the oils from which they were derived.

Acetostearin products are about as stable to polymerization and color changes at high temperature as are most hydrogenated vegetable oils. In Table 4 are recorded the changes in color and viscosity on heating an acetostearin product in air at 200° C.

**TABLE 3**
**Properties of aceto-olein products (9)**

| Product | Melting point, °C. | Consistency, cone penetration[1] mm./10 at −17° C. | Acetyl content, % | Iodine value |
|---|---|---|---|---|
| 1, 2-Diaceto-3-olein | −18.3 | liquid | 19.5 | 57.5 |
| Aceto-olein product from | | | | |
| Commercial oleic acid | −24.0 | liquid | 14.3 | 63.9 |
| Peanut oil | 16.5 | 118 | 14.0 | 68.3 |
| Pecan oil | −6.5 | 233 | 19.0 | 72.0 |
| Triolein | 5.0 | 3 | 0.0 | 84.3 |
| Peanut oil | 5.0 | 3 | 0.0 | 91.6 |
| Pecan oil | −5.0 | 3 | 0.0 | 103.9 |

[1] Method D 217-48 for petroleum greases as specified by the American Society for Testing Materials, except that weight of cone and movable attachments was 50 grams.

**TABLE 4**
**Changes in an acetostearin product maintained at 200° C. in the presence of air (11)**

| Heating time, hr. | Lovibond color yellow/red | Free fatty acids, as oleic, % | Viscosity, centistokes |
|---|---|---|---|
| 0 | 3/0.6 | 1.51 | 18.25 |
| 1 | 15/1.1 | ..... | 18.42 |
| 4 | 15/1.5 | ..... | 18.44 |
| 8 | 20/4.1 | ..... | 18.77 |
| 12 | 20/6.7 | 1.60 | 19.27 |
| 24 | 35/14.3 | 1.42 | 20.21 |
| 48 | 35/27.1 | 1.18 | 21.78 |

## EDIBILITY

*The acetoglycerides cannot be recommended for food use until absolute proof of edibility has been established in thorough and extensive tests by qualified pharmacologists and nutritionists.* Such proof has not yet been obtained. The necessary tests have been initiated, and in at least one case have been underway for a period of over 2 years, but they have not yet been completed.

Although glycerides containing acetic acid do not occur naturally, other esters of acetic acid do occur and

are found in many plants. Free acetic acid is produced by the action of various microorganisms and has been detected in animal secretions. Since the hydrolysis products of acetoglycerides are glycerol, acetic acid, fat-forming acids, and mono- and diglycerides, the acetoglycerides would be expected to be nutritionally acceptable. Feeding tests with triacetin to rats at a level of 55% of the diet show no deleterious effect *(6)*.

## POTENTIAL USES

The acetoglycerides have been tested for possible use in both food and non-food products. Most of these tests have been performed by commercial groups and in many instances the nature and results of the tests are not a matter of public record. A comprehensive list of potential uses has never been compiled. Those which will be discussed here are considered to be the more important.

Possibly the most promising use for the higher-melting acetostearin products is as a protective coating for processed meats. If a film a few mills in thickness is applied to frankfurters by dpiping them in a melted acetostearin product, the frankfurters on storage will lose moisture and color at a greatly reduced rate *(5)*. The initial rate of moisture loss at 4° C. can be approximately $\frac{1}{20}$ of that for uncoated frankfurters. Such films can be made practically invisible and can hardly be detected by touch. They either could be consumed with the frankfurters, or they could be removed with hot water prior to serving. Acetostearin films can be applied to other processed meats and possibly to some types of dressed meats. In addition to serving as reasonably good barriers to the transfer of moisture, there is some indication that they are good barriers to the transfer of oxygen. In this connection, antioxidants could be incorporated in the acetostearin products and their films would then serve to apply minute and uniform amounts of antioxidants to the surfaces of the dipped food products.

Under certain conditions it might be desirable to use coatings of high-melting acetostearins on other food products like dried fruit, cheese, and baked goods. For example, it might be desirable to put an acetostearin coating on certain cheeses when they are prepared for market. There does not seem to be an advantage in using such a coating on a cheese which is to be cured for 12 to 18 months. Under the latter conditions the impermeability of the coating to moisture is not great enough, and the coating itself is not tough enough to permit ordinary handling of large blocks of coated cheese.

The lower-melting acetostearins are potentially useful where a low-melting fat of extraordinary resistance to oxidation and rancidity is required. Preliminary experiments have shown that they may be desirable in a slab dressing in the manufacture of candy, as an oil on raisins to prevent packing, and as a roasting oil for nuts. These uses are being investigated.

The aceto-olein products, unlike those consisting largely of acetostearins, are potentially valuable as major ingredients in certain types of food products, one of which is a special, margarine-like spread desired by the Armed Forces. A spread is required which has a long plastic range and will be acceptable after storage for at least 6 months at 100° F. (38° C.). These requirements may be met by a mixture consisting of an aceto-olein product, partially hydrogenated cottonseed oil, finely ground salt, and traces of antioxidant, imitation butter flavor, and butter color *(9, 12)*. The mixtures can be made to resemble ordinary margarine in appearance and taste. Because they contain no moisture or milk solids, there is little tendency for spoilage by hydrolysis or bacterial action. Because the iodine value of aceto-oleins is relatively low and no glycerides of polyunsaturated acids need be present, the mixtures are quite resistant to oxidation.

The mixtures mentioned above can have a very long plastic range, though this simultaneously means some degree of waxy feel in the mouth. In Figure 3 the consistency-temperature curve of one mixture prepared with an aceto-olein product from commercial oleic acid (Table 3) is compared with that of commercial margarine.

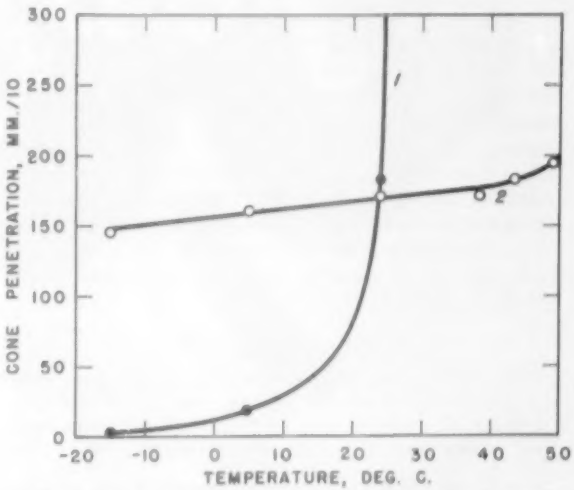


**Figure 3. Consistency vs. temperature curves: (1) margarine; (2) margarine-like product containing essentially 79% aceto-olein product derived from commercial oleic acid, 18.5% highly hydrogenated cottonseed oil, and 2.5% salt.**

Baur *(1, 4)* has presented data showing that aceto-olein products, or acetin fats, as he calls them, can be used with hard fats to make blended-type shortenings superior to present commercial shortenings with respect to baking performance, workability, creaming volume, and gum and foam formation. The single exception to comparable or superior performance is in a lower smoke point, which was 300° F. (149° C.) instead of the normal 400° F. (204° C.). The aceto-olein containing shortenings showed good resistance to heat damage and changes in texture on storage at 50-100° F. (10-38° C.).

One of the potential uses for both aceto-olein and acetostearin products is as a plasticizer for certain polymers or plastics, particularly if the plastic is to be formed into a sheet or film and used as a wrapper for food

products. In the latter situation any transfer of plasticizer from the wrapper to the food product would be harmless.

The aceto-oleins and acetostearins can be used as secondary plasticizers for vinyl resins *(19)*. Acetoglycerides from coconut oil have been used as plasticizers for certain esters of cellulose *(21)*. The acetylated monoglycerides from castor oil *(13)*, and epoxidized aceto-oleins *(17)* have also been shown to be useful as plasticizers for vinyl resins, though nothing is known about the toxicity of these types of acetoglycerides.

## SUMMARY

The preparation and properties of some unique fat and oil products obtained by substituting, in effect, acetic acid for some of the fatty acids ordinarily combined in fats and oils have been described.

By the proper choice of starting materials and degree of acetylation these new-type fats and oils or acetoglycerides can be tailored within limits to possess specific properties. Insofar as potential food uses are concerned, the acetoglycerides may be divided into three classes: (1) nongreasy, plastic fats of relatively sharp melting points for use as protective coating materials, (2) low-melting fats having extraordinary resistance to rancidity and, (3) low-melting oils which possess good resistance to rancidity and remain either liquid or plastic at temperatures far below freezing.

A number of possible uses for the various acetoglyceride products are described.

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## The FIRST and ONLY Product of Its Kind . . .

**M.C.P.**
BRAND

# "LOW SUGAR" PECTIN*

***That Makes***

**DIETETIC JAMS AND JELLIES, PIE AND TART FILLINGS, TOPPINGS, GELATIN-TEXTURED DESSERTS, Etc.**

**With LESS, LITTLE, or NO SUGAR AT ALL**

**1** **To Meet the Rigid Sugar and Starch Restrictions of Diabetic Diets**

**2** **To Meet the Exacting Requirements of Weight Control Diets**

**3** **To Meet the Taste Preference of Those Who Like Things "Less Sweet Than Usual"**

### THE ANSWER TO A LONG-UNSOLVED PROBLEM

For years, there has been a world-wide demand and need for a **sure, dependable** and **economical** means of preparing these products with the varying degrees of sweetness **necessary** for dietetic purposes or **desirable** from the standpoint of millions who merely like things "less sweet." M.C.P. "LOW SUGAR" PECTIN — developed **exclusively** by the Research Laboratory of Mutual Citrus Products Company — is the answer to this hitherto unsolved problem.

### AN ABSOLUTELY UNIQUE PECTIN

M.C.P. "LOW SUGAR" PECTIN is an **unique** pectin because, unlike ordinary pectins, liquid or powder, it requires no sugar to make these jellies and desserts, yet sugar may be added to satisfy any taste, or saccharin or sucaryl may be used as sweetening agents. It is a **revolutionary** pectin that only M.C.P. can offer, because it is patented and exclusive.

### TRY IT . . . WITHOUT COST . . . AND SEE FOR YOURSELF

It is impossible here to more than indicate the tremendous versatility and usefulness of M.C.P. "LOW SUGAR" PECTIN. Only by trying it can you see just how **effective** and valuable it is in your own operations. That's just what we wish you to do . . . and **at our expense.** Just fill out and mail the Coupon below, and we'll send you a GENEROUS FREE SAMPLE with recipes for using.

* **Licensed under U.S. Patents Nos. 2,392,854, 2,425,947, and 2,540,050. Other patents pending.**

**USE COUPON FOR FREE SAMPLE M.C.P. "LOW SUGAR" PECTIN**

*Mutual Citrus Products Co.*
*Anaheim, California* (6-O)

*Please send me the Free Sample of M.C.P. "LOW SUGAR" PECTIN which you offer, together with recipes for using.*

(PLEASE PRINT CLEARLY)

NAME_____

FIRM_____ POSITION_____

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CITY_____ ZONE_____ STATE_____

NOTE: For convenience in mailing, cut off Coupon and paste on 2c postcard. F T

# *how to bring a salesman right to the shelf!*

**Three of the many groups of foods and beverages that are increasing sales through**

You can give your carbonated beverage health appeal for just a *fraction of a cent* per bottle. That's all Pfizer vitamin-fortification costs. Bottlers are already using Vitamins $B_1$ and C as successful sales boosters to today's vitamin-conscious public. Vitamin $B_{12}$, a factor in child growth, is also being considered. Pfizer will be glad to work with you in fortifying your beverages.

It's a smart sales move to enrich flour, macaroni, corn meal and similar products with Pfizer BI-CAP® enrichment concentrates. They give such products more *food value*. This meets the increased demand for foods of all varieties in the diet that contribute to good nutrition—*regardless of calorie count!* Let Pfizer show you how BI-CAP can add sales appeal to *your* product.

**A vital "plus" to help you sell your product in today's self-service food store**

The grocery shelf on which your product stands is the point of *decision* for the consumer. Your package, your product and its ingredients are the main selling forces employed at that point in the all-important job of making that consumer put *your* brand in her shopping cart. And that's where Pfizer's vitamin fortification and enrichment program can become a "star salesman" for your product! For extra vitamin sales-appeal displayed on your package aims right at the basic desire of every shopper to give the family maximum nourishment. Your Pfizer sales representative is the logical man to see for the full story on how Pfizer vitamins, at nominal cost, can substantially increase your product's sales potential. He's backed by over 18 years of Pfizer vitamin experience in working with manufacturers of many types of foods and beverages. It's truly worth your while to talk to him.

**Pfizer vitamin fortification and enrichment**

To fortify your sales position in the canned juice, concentrate and fruit "ade" market, fortify these products with Pfizer vitamins. Health is a prime reason why people drink fruit juices. "Vitamin Fortified" on your label is a strong inducement to buy *your* brand. What's more, your vitamin content is standardized, offsetting processing losses and seasonal variations.

**CHAS. PFIZER & CO., INC.**

*Chemical Sales Division*

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Branch Offices: Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.

*Manufacturing Chemists for Over 100 Years*

Pfizer

*Whenever you have a food processing problem, talk it over with your Pfizer sales representative. He'll be glad to assist you.*

**MAGNA spice concentrols** — scientific formulations of spice essential oils and oleoresins . . . the most concentrated flavoring materials available.

*advantages:*

- 100% pure, natural products obtained by distillation or extraction from *actual* leaves, herbs, roots, buds or berries.
- Contain no diluents or inert materials of any kind.
- More economical because they are more concentrated, yet readily diluted in your own plant.

Write for your copy of "Questions and Answers" for the food processor. Learn how the development of Magna Spice Concentrols has modernized the seasoning of food products . . . and cut seasoning costs.

MAGNUS, MABEE & REYNARD, INC.

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## FOOD INDUSTRY TOPICS

(Continued from page 30 preceding technical papers)

to boost the meager Bulgarian diet, but rather for export to "foreign markets."

◆ ◆ ◆

One of the promising possibilities for increasing the world's food supply to match population growth is large-scale culture of microscopic algae, according to Dr. Austin W. Fisher, head of the Process Engineering Dept., Arthur D. Little, Inc., New York City. Dry algae has been demonstrated as a good food for animals, and offers promise as a supplementary human food. Active work now under way in Japan indicates possible early adoption of algae as a food. On the basis of his preliminary engineering experiments, Dr. Fisher states that a hypothetical plant could produce 6 tons of algae per day at a manufacturing cost of 25c lb. Extrapolation from present data indicates that 30 to 40 tons per acre per year should be possible. This offers the prospect of producing a high yield of food of good nutritive value from otherwise worthless land. However, he points out, many problems remain to be solved before a commercial plant can be designed.

◆ ◆ ◆

To consider the physical and engineering aspects of high-energy radiations and the techniques of applying them to industrial purposes, a one-week Special Summer Program on "Ionizing Radiations for Industrial Processing" will be offered at the Massachusetts Institute of Technology, June 20-24. Discussions, demonstration lectures, and visits to typical radiation sources are planned.

MIT also offers a review of basic facts and a consideration of important recent and current scientific developments concerned with foods and the food industry in a 3-week Special Summer Program on "Food Technology," June 20 - July 8. After one week of general lectures on food origin and composition, handling, transportation, storage, and control, members will choose one of 5 areas for specialized study during parts of the second and third weeks. Write Summer Session Office, Room 7-103, MIT, Cambridge 39, Mass.

◆ ◆ ◆

Glamour through packaging can sell more potatoes and help combat the threatening potato glut, according to Mr. A. T. Safford, Jr., sales manager for Olin Polyethylene. He pointed out that high-pressure promotional campaigns aimed at increasing potato consumption provided only part of the answer. He cited results of a recent survey made by the University of Maine. This survey showed that potato sales were in direct proportion to attractiveness of package. At the same price, 63.5% of the housewives chose potatoes sold in a polyethylene bag over those sold in a mesh window bag or a corrugated box. When sold at 2c to 4c a pound more than the others, 54% still preferred the polyethylene bagged potatoes. It also was shown that packaged potatoes sold better than loose potatoes.

◆ ◆ ◆

Public demand will force more stringent regulation of industrial firms that cause unpleasant odors and fumes, a survey of law enforcement officials in 67

(Continued on page 40)

# Only UNIFORMLY CONTROLLED CAN AGITATION GIVES FAST AND EVEN HEAT PENETRATION

**Compare!**

Conventional non-agitation type cooking, where heating is by conduction, is both slow and uneven. This type of cooking makes it necessary to overheat the product at the can's periphery in order to reach sterility at the center of the can. As a result, complete uniformity of product quality within the can is seldom possible.

## This superior Quality Control has made FMC "Sterilmatic"* the standard of processing equipment for finer canned foods

Within the "Sterilmatic" Continuous Pressure Cooker every can is cooked *evenly* and *exactly alike* through the combination of individual can rotation and agitation of the product within the can. Of course this rolling agitation and the consequent "basting" action depends on the consistency of the product. But the important point is that this is *induced convection heating*, which increases the rate of heat penetration, keeps cooking absolutely uniform, provides for the precise processing control you need to maintain consistently high standards of product quality.

When you compare the process and compare the results, you'll sooner or later replace with an FMC "Sterilmatic" Continuous Pressure Cooker and Cooler. So write today for full information, or call your nearest FMC representative.

NOTE: For products requiring very little agitation a special type of reel and spiral mechanism is provided.

*Trade Mark — Reg. U. S. Pat. Off.

**Write for free booklets!**

"The Sterilmatic Story" shows what this equipment can do for your operations.

"Sterilmatic Facts" includes all technical data and specifications of equipment.

Key To good equipment

**FOOD MACHINERY AND CHEMICAL CORPORATION**

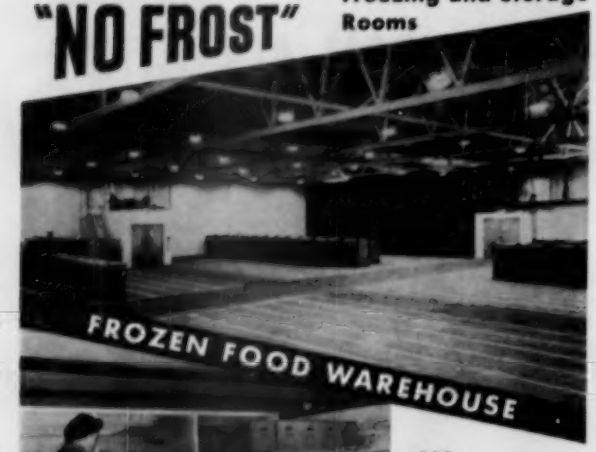
*Canning Machinery Division*

**General Sales Offices:**

**WESTERN:** SAN JOSE, CALIFORNIA

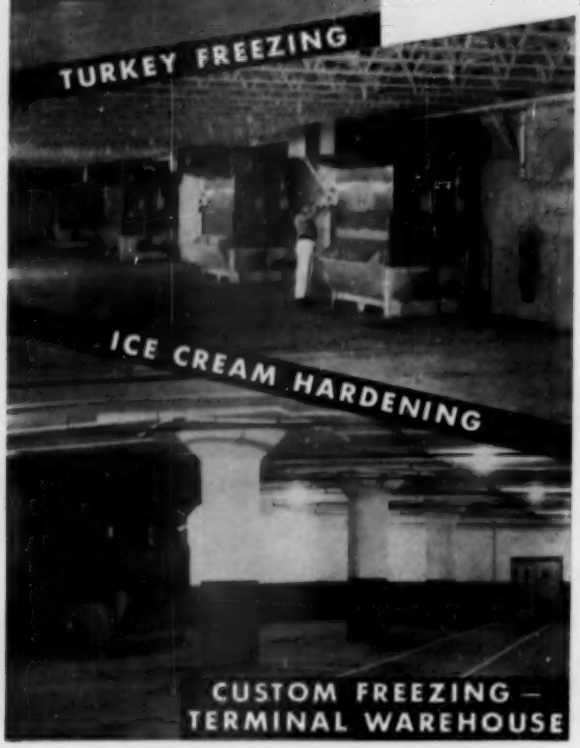
**EASTERN:** HOOPESTON, ILLINOIS

**NIAGARA "NO FROST"** *for* **Always Clean Food Freezing and Storage Rooms**



**FOR BETTER QUALITY FROZEN FOODS**

● Niagara "No-Frost" assures you of *always* clean, frost-free rooms for pre-cooling, freezing or frozen storage. You never have to shut down for defrosting or have a rise in temperature.

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**NIAGARA BLOWER COMPANY**

Dept. FT, 405 Lexington Ave. New York 17, N.Y.

*District Engineers in Principal Cities of United States and Canada*


## FOOD INDUSTRY TOPICS

(Continued from page 38)

major U. S. cities indicates. The survey was conducted by Pendray & Co., New York public relations firm. Among the officials who replied, 62% reported specific plans to intensify enforcement efforts. A total of 68% declared that public interest in odor problems is increasing, and over 40% said that complaints are rising. Industry is the major source of odor and fume problems, although vehicles and domestic causes rank high. In order of frequency of mention, these are the prime sources of complaints: chemicals, vehicles, paint and varnish, food processing, domestic causes, rendering plants, plastic, oil refineries, coke works, rubber, steel, insulation, fish, gas works, pharmaceutical, soap and detergents, and breweries. Most respondents stressed the need for more research into causes and cures.

◆ ◆ ◆

U. S. manufacturers of collapsible metal tubes, one of the oldest and most versatile of containers, have launched a nationwide campaign to promote packaging of food in tubes. Jelly is the first product in the industry-wide effort of the 16-member Collapsible Tube Manufacturers Council to put paste-like food products in fold-up metal tubes. The industry, which produces nearly a billion units a year, believes its containers ultimately will play an important part in the packaging of fish and meat pastes, caviar, cheese spreads, mustard, mayonnaise, catsup, honey, peanut butter, and other semi-liquid or paste-like products in addition to jelly.

◆ ◆ ◆

One hundred nineteen courses in subjects ranging from industrial psychology to engineering economics will be offered by Illinois Institute of Technology at its 1955 summer session, June 27 - August 19. Registration will be held June 22 for evening students and June 23 for day students in Room 101, Main Bldg., 3300 Federal St., Chicago.

### . . . *things new under the sun*

A small company in Massachusetts has developed an **entirely new method of using a nuclear reactor** to produce very large quantities of gamma radiation, free of neutrons, and at relatively low cost. As a result, many proposed processes based on utilization of penetrating radiation may become commercially feasible. Because of the absence of neutrons, the materials so treated will not become radioactive. Further, many processes now can be brought from the experimental stage through pilot plant to final production without the usual concern with scale-up of problems and with excellent estimates in advance of cost of production. The firm, The Gamma Corporation of Mansfield, Mass., plans to construct a reactor facility based on the new principle and lease it to industry, research institutes, and universities for studies on effects of neutron-free gamma radiation on raw materials, processes, and finished goods.

◆ ◆ ◆

**A new packaging development** which combines use of a revolving plastic disc with metal cans for pouring or sifting a variety of food and non-food products was

(Continued on page 42)

.18¢ of real

**BLACK WALNUT WONEX**

flavors 150 lbs. of cream centers or 10 gals. of ice cream mix

Black Walnut Wonex contains no synthetics — only real walnuts and other natural extractives. So concentrated that 1½ ozs. flavors 150 lbs. of cream centers, 10 gals. of mix. True flavor remains constant. $16.00 per gal.

**Dr. Alexander Katz Co.**
*Division of*
**F. RITTER & CO.**
**Los Angeles 39, California**
*Branch Offices in Principal U.S. and Foreign Cities*

*coffee concentrate with*
**COFFEE MERCAPTAN**
*(a natural constituent) gives ice cream and candy a real coffee flavor*

*Our coffee concentrate is particularly recommended for coffee blacks and ice cream. Coffee Mercaptan restores freshly ground flavor to instant coffee. $12.00 per gal.*

**Dr. Alexander Katz Co.**
*Division of*
**F. RITTER & CO.**
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**CYCLOROME-10** MAGNIFIES ANY FINE FLAVOR

*Cyclorome-10 is a pure aromatic ketone. Indispensable to intensify and stabilize fine flavors. Heat resistant. Completely soluble in propylene glycol. Use up to 10% in maple, butterscotch, and caramel flavors. Price: $18.00 per lb.*

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**Los Angeles 39, California**
*Branch Offices in Principal U.S. and Foreign Cities*

*Maple Elpam is the original authentic reproduction of maple sap aroma and flavor. Just 3 ozs. produce 1 gal. of flavor, of which 1 oz. flavors a gal. of syrup. For cream centers, use 6 oz. dilution in water, 2 ozs. of which make 50 lbs. of cream centers. Price: $3.75 per lb. Quantity quotations on request.*

**Dr. Alexander Katz Co.**
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Ultra-violet spectrophotometer provided valuable data in the development of Permaseal Flavor Crystals and is used in quality control.

## Givaudan sets a New Standard of Quality and Stability with

# PERMASEAL FLAVOR CRYSTALS

Givaudan's new series of Permaseal Flavor Crystals is the result of extensive research conducted to provide you with superior powdered flavors at a new low cost.

They are produced by a special Givaudan-developed cold process that prevents flavor deterioration. Coatings are made of carefully selected materials that protect the freshness of the oils, and are highly soluble.

Here are flavor crystals that offer new and unique advantages for cake mixes, instant icings and frostings, powdered ice cream and sherbet mixes, puddings and pie fillings, gelatin dessert and summer drink powders, and other flavored products sold or transported in powdered form. And because of the flexibility of this new process, Givaudan can custom-make special flavors for your particular needs.

Givaudan Flavors Inc.

330 West 42nd St., New York 36, N. Y.

Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Atlanta • Seattle • Los Angeles • Toronto




## FOOD INDUSTRY TOPICS

(Continued from page 40)

introduced by American Can Co., New York City. In the new package, the dispensing disc (patent pending) fits snugly and flatly into the recess of a modified end of Canco's sanitary-type container and revolves easily to the desired position to open, sift, pour, or close. It is held in place by an inward flanging of the double-seamed top edge of the can. According to Canco, application of this plastic disc to metal containers which can be produced economically in all standard sizes on high speed equipment will broaden use of the modern metal can for many products now sold in other types of packages.

◆ ◆ ◆

A new Butyro Refractometer designed to **increase the speed and accuracy of purity tests made on edible oils** was introduced by Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y. The instrument will find many applications in plants processing edible oils, according to the manufacturer. The Butyro Refractometer is sold complete with eyepiece scale, one set of prisms, thermometer assembly, test piece, and carrying case for $490. It is described in Catalog No. D-273, available from the company.

◆ ◆ ◆

A new and expanded line of standard "U" type Heat Exchangers was announced recently by Bell & Gossett Co., Morton Grove, Ill., manufacturers of hot water heating specialties, centrifugal pumps, and refrigeration equipment. Chief use of the "SU" Series is for heating water with steam in capacities from 16 g.p.m. to 1200 g.p.m. It is also an efficient heater for other liquids and an excellent condensate cooler. Constructed for 150 psi working pressure, it is available also in ASME code material and construction at no extra charge. Catalogs available on request.

◆ ◆ ◆

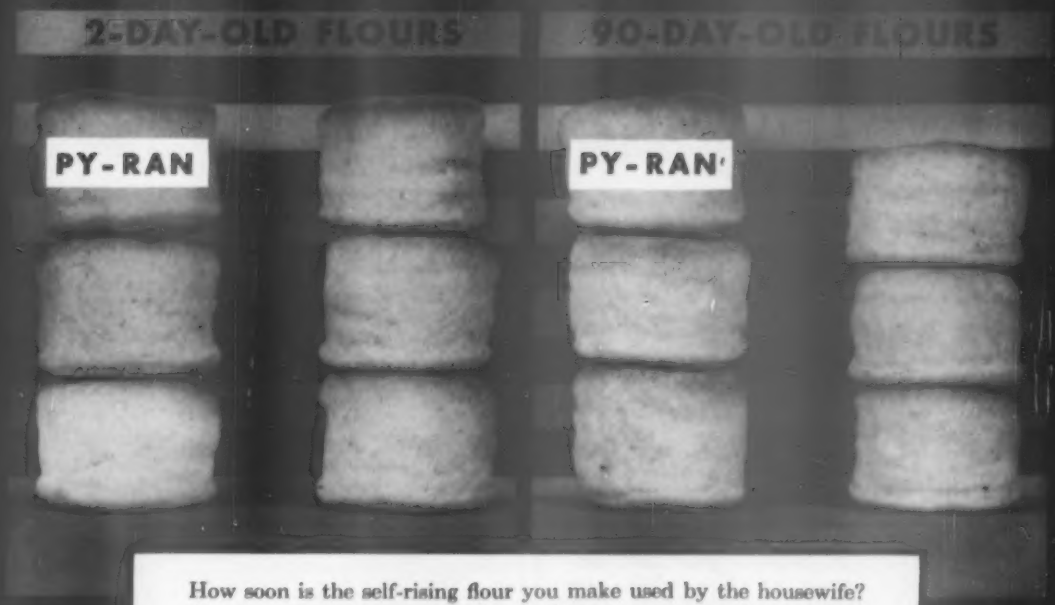
**A completely air-conditioned test cabinet** that provides full control of relative humidity and temperature for testing materials, products, or specimens is announced by Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y. The method used is that of saturating air at the required dew-point temperature and reheating to the desired dry-bulb temperature. Control of R.H. to close tolerances is given in the range of 5% to 95%. The dry-bulb temperature at which this control is provided depends on the collateral services afforded. No moisture-sensitive instruments are required to achieve and hold the control, and recording instruments may be used. Dimensions are 30″ x 28″ x 24″ clear opening for access of 26″ x 22″.

◆ ◆ ◆

V.I.S. (Vacuum Impregnated Spice) Kosher Dill Seasoning is stated by the manufacturer, Baltimore Spice Co., 12 S. Front St., Baltimore 2, Md., to be the answer to the pickle-packers' prayers. In the process, patent applied for, plump, clean coriander seeds are vacuum impregnated with the pure extractives of

(Continued on page 44)

# 90-day self-rising flour test proves PY-RAN* gives longer shelf life




How soon is the self-rising flour you make used by the housewife? Not in 2 days or a week. More like 30 to 90 days! Here flour leavened with PY-RAN and flour using another calcium phosphate give about equal results when 2 days old. But—when the flours are aged in a heatilator to equal 90 days of package life, only the PY-RAN flour performs like new. The other definitely loses its strength.

**PY-RAN'S MOISTURE-ABSORBENT COATING WARDS OFF TOO-EARLY REACTION.** Each granule of PY-RAN (monocalcium phosphate) has a moisture-absorbent coating to prevent too-early reaction. Result: longer shelf life for prepared mixes and self-rising flour—minimum of returned goods.

**MONSANTO'S PY-RAN HOLDS MAXIMUM LEAVENING ACTION FOR OVEN.** PY-RAN releases less $CO_2$ during the first two minutes of the mixing of the dough or batter. PY-RAN saves its leavening action for the oven.

**PY-RAN GIVES SUPERB TEXTURE, VOLUME, CRUST AND CRUMB COLOR.** PY-RAN blends perfectly with other leavening agents. Its slow controlled gas release gives excellent texture, volume, and crust and crumb color; almost no tunneling.

**MONSANTO OFFERS FULL LEAVENING LINE** including: SAPP-40 for machine doughnut mixes; SAPP-28, a slow-action baking acid; and HT* Phosphate (MCP monohydrate).

**FREE BOOKLET,** "MONSANTO PHOSPHATE LEAVENING AGENTS." Write: MONSANTO CHEMICAL COMPANY, Inorganic Chemicals Division, 710 North Twelfth Street, St. Louis 1, Missouri.

**LEAVENING SCHOOL FOR MONSANTO SALESMEN** so they can learn your business in order to help you. This is the only school of its type in the industry.

*Reg. U. S. Pat. Off.*

MONSANTO

SERVING INDUSTRY WHICH SERVES MANKIND

Leavening Phosphates From Monsanto Chemical Company

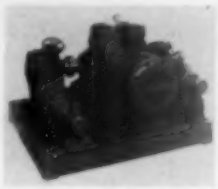
WORLD'S LARGEST PRODUCER OF ELEMENTAL PHOSPHORUS

## FOOD INDUSTRY TOPICS

(Continued from page 42)

finest dill weed, fresh garlic, and a mixture of other selected spices to give a true, Kosher style dill flavor. To prove its claim of quality and economy, the manufacturer offers a free 4-ounce sample, sufficient to flavor a dozen cases of pickles.

◆ ◆ ◆



A new Controlled Volume Pump, engineered for **precise control of fluid flow at pressures ranging from 7500 to 50,000 psi,** has been announced by Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa. Ideal for high pressure syntheses, hydrostatic pressure testing, and high pressure fluid metering, the flow control instrument reportedly provides precise metering accuracy at higher capacities and higher pressures. Seven units are offered.

◆ ◆ ◆

**A versatile new electronic laboratory control device** known as the Superlay, tested over 28,000,000 times without a breakdown, was introduced April 19 by Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, for use in controlling high current units such as incandescent lamps, heating elements, and solenoids. Laboratory applications include constant temperature applications, pressure and water-level control, and direct photo-tube operation for control and counting operations. Recommended for temperature control devices using bi-metallic strip and mercury thermoregulators as well as resistance and incandescent loads.

◆ ◆ ◆

What is believed to be the **first metallic colored, plastic food casing** has been developed by Plastic Films Division of Tee-Pak Inc., 3520 S. Morgan St., Chicago 9, Ill. Available in either Saran roll stock or Saran tubes, used in chub packaging of meats, spreads, and other food products. Colors developed so far are gold and silver. The double-wound casings are manufactured under the firm's patented Unilox printing process.

◆ ◆ ◆

A new $50,000,000 American Cyanamid Company petrochemical plant at Fortier, La., is successfully using continuous infrared analyzers to control the purity and output of its process stream, it was announced by Dr. Van Zandt Williams, vice president and director of sales and research of the Perkin-Elmer Corp., Norwalk, Conn., manufacturers of the instruments. These analytical "watchdogs" — TRI-NON Analyzers—mark the first time such continuous analytical controls were designed into the process stream of a chemical plant of this size.

◆ ◆ ◆

The modern use of prepared "ready mixes" common to the housewife in her kitchen has been adapted to the laboratory with introduction of a **newly developed ready-to-use standard solution** by the Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago. The solutions, called "Stansols," bear a guarantee for accuracy within one part in 1000, and are standardized 5 times before packaging. Standard solutions are widely used in industrial and chemical laboratories

(Continued on page 46)

# STABLE—from container to customer

# MERCK VITAMIN A

Stability is a prime quality of MERCK VITAMIN A. Our chemists have established this by many tests, including collaborative work with manufacturer-customers. Many margarines fortified with MERCK VITAMIN A have maintained their free vitamin A potency, even after 5 months of storage at 40° F.

This assured stability of MERCK VITAMIN A helps to ensure product quality. Available as the Palmitate or the Acetate, MERCK VITAMIN A is consistently light-colored, clear and homogeneous, and free from off-tastes and odors. Batch size or bulk containers are offered to meet every need. And Merck Technical Service is always ready to aid you in applying vitamin A to your products.

## OTHER MERCK PRODUCTS FOR THE FOOD INDUSTRY

ASCORBIC ACID
CITRIC ACID
RIBOFLAVIN
THIAMINE
NIACIN
SODIUM CITRATE
SODIUM BENZOATE
VITAMIN MIXTURES
VITAMIN WAFERS

*Research and Production for the Nation's Health*

MERCK & CO., INC.
*Manufacturing Chemists*
RAHWAY, NEW JERSEY

© Merck & Co., Inc.

## FOOD INDUSTRY TOPICS

(Continued from page 44)

as reference solutions for testing chemical formulas in research and control work. The firm is marketing "Stansols" in a wide variety of solutions, and any type of solution for particular needs can be developed.

◆ ◆ ◆

Central Scientific Company, 1700 Irving Park Rd., Chicago, Ill., offers a **new line of mechanical vacuum pumps** which operate quietly and with practically no vibration. In addition, the pump, named the Hyvac 7, is claimed to have more pumping capacity per cubic foot of space occupied than any other high vacuum pump on the market. The unit produces a free air displacement of 70 liters per minute and a guaranteed ultimate vacuum of 0.1 micron, yet floor space requirement is only 8½" x 17½", with over-all height of about 13". Available with ⅓ h.p. motor for 115/230 volts, 60 or 50 cycles, or 220/440 three-phase, 50/60 cycles, and with explosion-proof motor. Price, with base and motor, for 115/230 volts, 60 cycles, is $254.50.

◆ ◆ ◆

Ritter Cyclorome-10, an aromatic of ketonic nature having a decided taste of maple, walnut, butterscotch, and licorice, is offered by F. Ritter & Co., 4001 Goodwin Ave., Los Angeles 39, Calif., as valuable as an improver in compounding fruit flavors, improving ice cream, pudding, hard candy, maple, coffee, chocolate, vanilla, liqueur, and soft drink flavors, and as blending well with oil of bitter almond, benzaldehyde, and tolyl aldehyde. Price is $18.00 lb. in quantities of one and 5 pounds or more. In quantities of 100 pounds or more, it is $16.00 lb. All prices f.o.b., Los Angeles.

◆ ◆ ◆

**An improved moisture measurement instrument,** the G5 Moisture Register, indicates the percent of moisture in granular substances, first placing the material under hydraulic compression for uniformity. Newly developed miniature tubes used in a radio frequency power absorption circuit result in a more compact, stable instrument giving instantaneous readings as low as 0% within close tolerances. Portable and designed for accurate testing on production lines. No technical training required of operator. For technical literature write Moisture Register Co., 1510 W. Chestnut St., Alhambra, Calif.

◆ ◆ ◆

Arnold O. Beckman, Inc., 1020 Mission St., Pasadena, Calif., pioneers of paramagnetic Oxygen Analyzers that provide a direct physical measurement of oxygen content, announce Model C2P Oxygen Analyzer—particularly designed for applications requiring a quick, simple, accurate means of measuring oxy-

(Continued on page 48)


Is a link missing in your Quality Control Chain?

But he can *be prepared* in advance to spot the trouble *the moment it occurs* by using

cook chex

No Food Technologist can tell *in advance* when a batch is going to "go bad."

...MPERATURE SPECIFICATIONS FOR FREE COOK-...ATORS CUSTOM-MADE TO FIT YOUR REQUIREMENTS

COOK-CHEX
11471 Vanowen St. North Hollywood, Calif. FT-6

Without obligation, please send me a supply of COOK-CHEX indicator tags designed for use at _____ degrees F., for _____ minutes.

Name _____

Position _____ Company _____

Address _____

City _____ State _____

Sausage makers should use Morton '999' because of its milder, more uniform flavor. Its uniform granulation results in a more even dissolving rate and improved salt distribution throughout the sausage. Morton '999' has a minimum pro-oxidant effect. To insure good flavor and to prevent quality variations, Morton '999' Salt should also be used by makers and processors of candy . . . beer . . . canned foods . . . cereals . . . seasonings . . . meat . . . malted milk . . . mayonnaise . . . margarine . . . sauerkraut . . . olives.

**MORTON '999' SALT insures uniform quality** in processed foods for two reasons. It's guaranteed to contain more than 99.9% pure sodium chloride—*always!* The 0.1% (or less) is a neutral inert sodium salt—never bitter calcium or magnesium compounds.

Vacuum pan evaporation assures that this salt will be clean . . . free-flowing . . . evenly soluble. It has a constant weight per volume ratio . . . won't pack down.

**MORTON SALT COMPANY**
Industrial Division, Dept. FT–6
120 So. LaSalle St., Chicago 3, Illinois

**I should like to have a Morton representative call and give me—without obligation—more information on Morton '999' Salt and methods of using it in my product.**

Name_____

Title_____

Company_____

Address_____

City_____ State_____

# MORTON '999'

**the salt that carries its own guarantee**

**Mail coupon for further details today!**

## FOOD INDUSTRY TOPICS

(Continued from page 46)

gen with an instrument that is portable (12 lbs.). The unit can be used for measuring continuously flowing samples, or for fixed volume samples as small as 3 cc. It can be obtained in practically any desired range of 5% or more between 0 and 75% oxygen—and in ranges of 15% or more between 75% and 100% oxygen.

◆ ◆ ◆

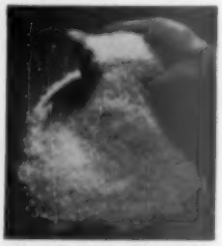
A new coating called Acanal, that protects from the corrosive action of acids, alkalis, fruit juices, salts, petroleum products, or alcohol, has been announced by Garland Co., 3748 E. 91st St., Cleveland 5, O. According to the firm, Acanal gives excellent results on tanks, chemical equipment, piping, machinery, structural steel, air ducts, trucks, floors, and walls. It is non-toxic and will not impart flavor to food or beverages after it has dried.

◆ ◆ ◆

**A dual-range electronic control system** which makes it possible to use the same mechanical refrigerator cars in shipping either fresh or frozen foods is announced by Minneapolis-Honeywell Regulator Co., 4569 Wayne Ave., Philadelphia 44, Pa. Featuring an upper range of 20° to 70° F. for the shipment of fresh produce and a lower range of —10° to 5° F. for frozen foods, the control maintains precise accuracy under a variety of operating conditions. It is not affected by altitude, needs no compensation for ambient temperatures, and uses no capillary tubes. Adaptable to many types of refrigeration equipment and cars.

◆ ◆ ◆

Official introduction of the **new Eastman polyethylene wax,** to be known as EPOLENE, was made recently by Eastman Chemical Products, Inc., New York City. The new wax will be of interest to packaging engineers, wax compounders, polish manufacturers, and converters looking for less-expensive substitutes for high-cost commercial wax ingredients. Eastman also announces another new product — half-second butyrate in convenient powder form. The new heat-sealing compound works best with any porous or semi-porous material, and is most effective on papers, cloths, and wood. There is indication, too, that it can be used on aluminum foil. For further information and samples write the company c/o Kenyon & Eckhardt Inc., 247 Park Ave., New York 17, N. Y.



New Eastman EPOLENE

◆ ◆ ◆

The phrase, "To Open, Use Lid Flipper," will be used to amplify the traditional "To Open, Pry Off" instructions on more than 700,000,000 vacuum seal caps slated for use during the next year, it was announced by IFT member John C. Swift, general sales

(Continued on page 50)

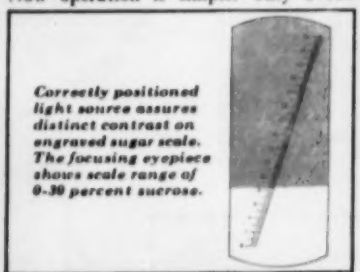

# When to Pick or Pack? *Know in Seconds!*

## New AO Hand Refractometer Determines Dissolved Solids Instantly!

*New AO Hand Refractometer with anodized aluminum finish*

Here's real news for food processors and growers! With AO's new Hand Refractometer accurate readings of the percentage of dissolved, solids, particularly sucrose, are made on the spot . . . instantly!

Gone is the need for any reference to a thermometer or to temperature correction tables. The secret? AO's design engineers have simplified the temperature correction procedure by means of an exclusive, internal compensating device. Now operation is simple. Only a few drops of a sample need to be placed on the surface of the measuring prism. Using either transmitted or reflected light, the refractometer provides *immediate readings* from an internal graduated scale (range: 0-30 per cent sucrose) which is visible through the focusing eyepiece. Accuracy is assured to 0.1 percent.



*Correctly positioned light source assures distinct contrast on engraved sugar scale. The focusing eyepiece shows scale range of 0-30 percent sucrose.*

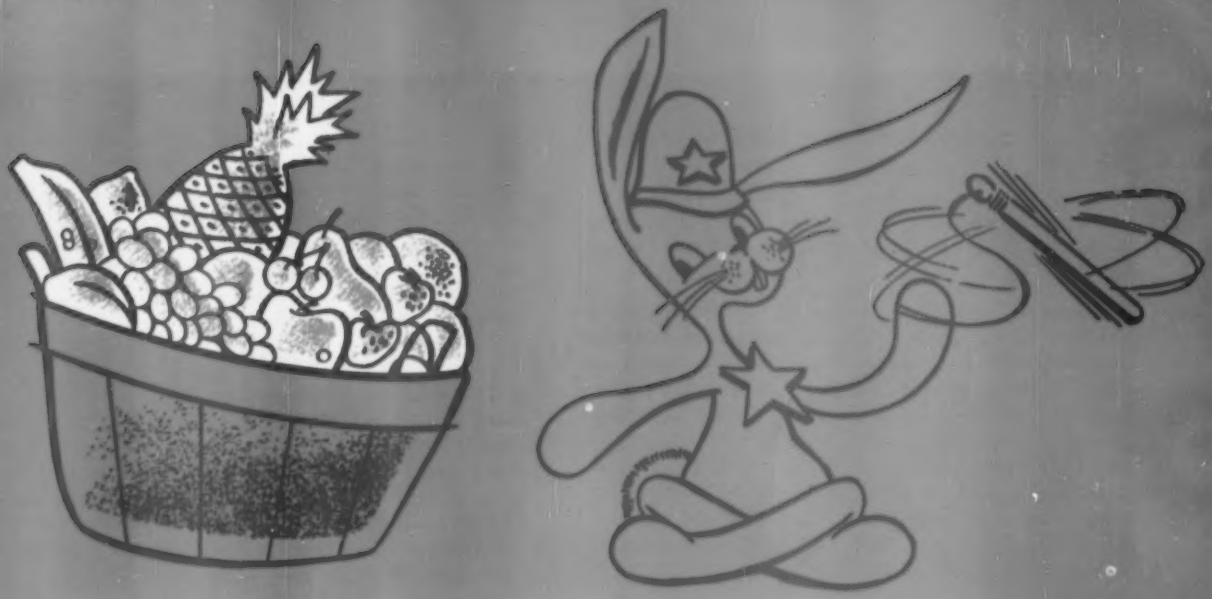
A built-in light source assures ideally positioned illumination under all conditions. Made of anodized aluminum, the new refractometer is light weight, easy to clean. An ever-ready top grain leather carrying case permits use of instrument without removal from case.

If you test raw products for ripeness; if you process fresh juices, syrups, tomatoes, etc., write Dept. R190, American Optical Company; Buffalo 15, New York, for complete information on the new Refractometer. Ask for CATALOG L20.

*Light wherever you go! Opening on underside of carrying case shows thumb button for built-in light source*

American Optical

INSTRUMENT DIVISION, BUFFALO 15, N. Y.



# FULL FLAVOR PROTECTION

with **Sealva** the hermetically sealed flavors.

The famous SEALVA process—of hermetically sealing minute droplets of flavoring oils within an edible gum film—provides a flavor in which even the most fugitive components remain unchanged in their fresh original state over extended periods of shelf-life.

SEALVA flavors—in commercial use for almost three years—give manufacturers a dry powdered flavoring material protected against oxidation, and volatilization.

SEALVA flavors have been enthusiastically adopted by makers of

- CAKE MIXES
- GELATIN DESSERTS
- CEREALS
- SUMMER DRINK POWDERS
- PUDDING MIXES
- DAIRY MIXES
- ICE CREAM MIXES
- CANDIES (pressed wafers)
- PHARMACEUTICALS

For samples and technical recommendations for adapting SEALVA flavors to your product, write

VAN AMERINGEN-HAEBLER, INC.
521 WEST 57th STREET, NEW YORK 19, N. Y.

Alva FLAVORS

## FOOD INDUSTRY TOPICS

(Continued from page 48)

manager of the White Cap Co., 1819 N. Major Ave., Chicago, the nation's largest maker of pry-off caps. Developed by White Cap, the lid flipper is manufactured by Ekco Products Co., Chicago.

◆ ◆ ◆

For handling of bulk materials, Gifford-Wood Co., Hudson, N. Y., announces a **new oscillating conveyor** designed with a minimum of moving parts. According to G-W officials, it requires practically no maintenance. The G-W Oscilveyor is a vibrating trough driven by rotating eccentric weights. Its components are 1) a drive unit, 2) a trough resting on rocker arms and coiled springs, and 3) a supporting base frame. Of unit construction, each Oscilveyor is made up of one drive unit and any number of standard trough units. Advantages include small power consumption, low headroom requirement, no spilling or leakage possible, and easy cleaning.

◆ ◆ ◆

A self-cleaning Hoffman-Hygrade closed-type pressure filter designed for filtration of liquids down to one-tenth of a micron, and for the minute filtration of chemicals, oils, and fats has been developed by the United States Hoffman Machinery Corp., 105 Fourth Ave., New York 3, N. Y. The filter has wide application for use by brewers, chemical and cosmetic manufacturers, oil and fat processors, and food and pharmaceutical plants. Because it requires no filter bags, sheets, or pads, costly maintenance and high labor cost are eliminated. The unit virtually eliminates loss of valuable liquids through spillage. The complete assembly, consisting of a pre-coating tank, splash-proof electric motor, pump, filter pressure chamber, valves for suction and discharge flow, and a pressure gauge, may be mounted on a portable platform and used at filtration points throughout the plant.

### . . . *the literary corner*

The Printing Processes Seminar of the 16th Annual Forum of Packaging Institute, 342 Madison Ave., New York 17, N. Y., is available as a separate document at $2.25 a copy. This Seminar is a stenographic transcript of the talks originally published in the *Proceedings* of the 16th Annual Forum which sells at $10.00 a copy for the 2 volumes. Also available is the Third Edition of the Directory of Contract Packagers, listing equipment and other packaging facilities of some 163 plants that accept contract packaging work, special facilities available, and type and kind of materials that are acceptable or unacceptable. Price is $5.00 per copy.

◆ ◆ ◆

According to *Glycerine Facts*, April 15, 1955, issued by Glycerine Producers' Assn., 295 Madison Ave., New York 17, N. Y., commercial production of synthetic glycerine by Dow Chemical Company at Midland, Texas, is scheduled for a date between July

(Continued on page 52)

ACCESSORY NUTRIENT FACTORS

*For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of*

EXCHANGE BRAND ORANGE SERUM AGAR #77

*(Dehydrated) a Complete Culture Medium*

| FORMULA | | |
|---|---|---|
| *Ingredients—when rehydrated on basis of 45 grams per liter of medium.* | Orange juice serum solids | 12.6g* |
| | Agar (dry basis) | 15g |
| | Peptone | 10g |
| | Yeast hydrolysate | 3g |
| | Reducing sugars, total | 8g |
| | Sucrose, total | 6g |
| | Cysteine hydrochloride | 0.001g |

*Buffered with 0.2 to 0.6g $K_2HPO_4$ to provide pH 5.5 ± 0.05 after sterilization.*

**Equivalent to 100 ml 12° Brix orange juice serum.*

**STANDARDIZED** for uniformity and stability.

**POTENTIAL APPLICATION**—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

**Sunkist Growers**

PRODUCTS DEPARTMENT

Exchange

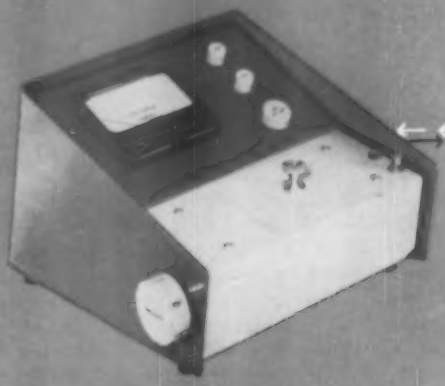
PHARMACEUTICAL SALES • ONTARIO, CALIFORNIA

sugar

# WHITENESS

## -without guesswork

The Beckman Sugar Colorimeter removes all doubt about the whiteness of sugar. No longer do you have to depend upon visual judgment or expensive laboratory methods. Designed for laboratory precision, this relatively inexpensive instrument is so simple to operate that unskilled laboratory personnel can learn to use it accurately in less than an hour. A turn of a three-position dial gives percent light transmittance readings at the 420, 560, and 720-millimicron wavelengths, instantly without fuss or bother. These readings pinpoint sugar whiteness exactly. Whether your product is confectionery, bakery goods, or beverage, sugar whiteness can profoundly influence its acceptability—and you need the Beckman Sugar Colorimeter.



*Write for Data File 55-84*

*Beckman Division*

BECKMAN INSTRUMENTS, INC. • *Fullerton, California*

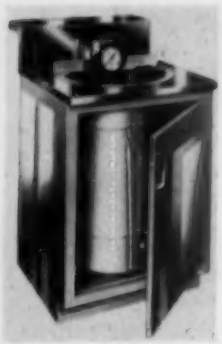
## FOOD INDUSTRY TOPICS

(Continued from page 50)

1 and October 1. New Shell Chemical capacity is expected to start reaching the market in June. Moreover, Shell has recently announced another program to make synthetic glycerine by a new process based on hydrogen peroxide and acrolein.

◆ ◆ ◆

Labline, Inc., and its affiliate, Chicago Surgical and Electrical Co., now located in new, modern quarters at 3070-82 W. Grand Ave., Chicago 22, offer the following Bulletins on their rapidly expanding line of laboratory apparatus: No. 4013 describing stainless steel Reid Vapor Pressure Baths, equipped with electronic relay, preset 100° F. regulator, and immersion heater; No. 13150 on 2-, 3-, 4-, 6-, and 10-rack Serological Water Baths, featuring lifetime radiant wall heaters, stainless steel exteriors, and hydraulically operated thermostat; No. 4109 on new Grease Penetration Cone of magnesium with stainless steel tip; No. LS 1040 on new Labline-Seta Smoke Point Apparatus for jet fuel tests, ASTM D 1322; No. 3610 describing Duo-Vac Oven ideal for vacuum processing of newly developed transistors; No. 1270 on new King-Size Magne-Stir, for stirring or mixing in open or closed vessels; No. 1274T on 4 new types of patented Egg-Shaped Stirring Bars, suitable for all types of magnetic stirrers; No. 23505 on a new line of hot wall, electrically heated sterilizers for temperatures up to 500° F.; No. 5034 describing new 4-unit Power-Pak for use with paper electrophoresis apparatus; and No. 26100 on a new Constant Temperature Bath featuring anodized aluminum interior chamber, with thermostatic control up to 160° F.



Reid Vapor Pressure Bath

◆ ◆ ◆

"Caviar for the General Public," and "Beware the Gold Bug" are 2 of the highly readable articles in the March 1955 issue of *What's New in Food and Drug Research*, published by Food Research Laboratories, Inc., 48-14 33rd St., Long Island City 1, N. Y. The former treats of plans to utilize the 5 to 10 million pounds of salmon eggs available in Alaska during a fishing season in the production of a smoked salmon caviar spread. The latter article contains valuable reminders concerning 4 principal types of food-borne infections and intoxications particularly dangerous in the summer.

◆ ◆ ◆

The Committee on Pesticides of the American Medical Ass'n., 535 N. Dearborn St., Chicago 10, Ill., announces availability of its latest report entitled "Outlines of Information on Pesticides: Part 1—Agricultural Fungicides."

◆ ◆ ◆

Fritzsche Brothers, Inc., 76 Ninth Ave., New York City 11, announces its latest wholesale price list (April 1955) available free to processors whose purchases are in wholesale quantities. In the new product line, the firm announces a semi-fluid, decolorized Oleoresin Black Pepper particularly applicable to the seasoning of meat products where the natural green of black pepper is objectionable. Free testing samples available upon request.

◆ ◆ ◆

An attractive 6-page color brochure, "Protect Product Quality," which describes use of the RCA Metal Detector in spotting all kinds of tramp metal in pre-packaging or final inspections is available from Radio Corporation of America, Engineering Products Div., Camden 2, N. J.

◆ ◆ ◆

A new 4-page folder describing their line of automatic packaging equipment has been issued by PAK-RAPID, INC., 530 N. 21st St., Philadelphia 30, Pa. The folder describes how the equipment performs countless packaging operations and meets and exceeds requirements of many different industries packaging an almost endless variety of products.

◆ ◆ ◆

A brochure describing a new type of membrane filter for use in research, production, and quality control is offered by Millipore Filter Corp., 36 Pleasant St., Watertown 72, Mass. The spiral-bound booklet gives detailed information on use of the filter in microbiological studies; analysis of acid mists, metals, fumes, and smokes; quality control in food and beverage industries; research in drugs and pharmaceuticals, and other areas.

◆ ◆ ◆

Availability of a catalog of plastic containers, only such catalog to be offered the packaging industry, is announced by the Plastics Merchandising Section, The Dow Chemical Co., Midland, Mich. The catalog presents a complete selection of nearly 200 different containers made of Styron (Dow polystyrene) plastic. Each container is photographed to show its detail, and the size, type of lid or cover, hinge description, and color of the container are listed. Also provided is name of sales manager of each firm and complete address.

◆ ◆ ◆

The new 1955 bulletin of Chemical Specialties Research Laboratories, Box 33, Ansonia Station, New York 23, N. Y., lists analyses of over 750 household and automotive chemical specialties including waxes, polishes, detergents, cleaners, shampoos, and deodorants. The analytical reports contain a complete chemical analysis with qualitative and quantitative data and an interpretation in terms of commercial ingredients. The reports are available at $15.00. The 1955 bulletin also makes available the manufacturing formulas of 8 specialties, including a wax, degreaser, and handsoap. These formulas, at $25.00, contain information to permit immediate production, including sources of raw materials, equipment needed, and manufacturing process.

◆ ◆ ◆

New, 26-page Bulletin L701 describing the complete line of liquid level gauges for indicating, recording, controlling, and telemetering has been released by The

(Continued on page 54)

**In many plants,** Celite diatomite filtration has helped process control men maintain the desired balance between clarity and flow rate.

# CELITE FILTRATION assures perfect clarity at fastest flow rates

*For maximum clarity,* Celite* offers a filter cake hundreds of times finer than the finest wire mesh. *For maximum flow rate,* Celite offers more than 2,500,000 filter channels in every square inch of the filter cake's surface. Thus, you can maintain highest quality without handicapping your production schedule . . . expand production without creating a clarification bottleneck.

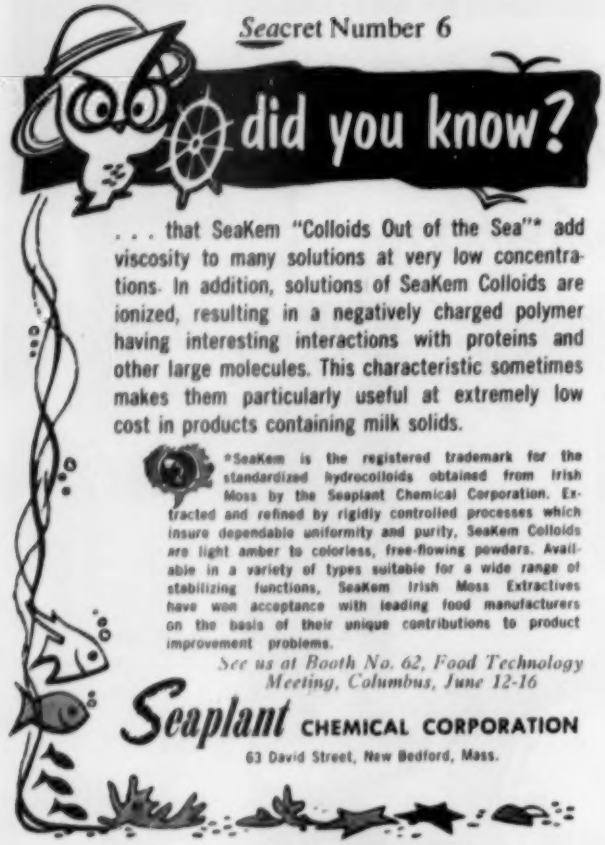
Celite is diatomite . . . works with almost automatic ease with any standard pressure filter. To meet your specific requirements, Celite comes in nine standard grades of microscopically controlled particle size.

Celite is in wide use today filtering sugar, beer, jellies, syrups, cooking fats and oils. If your product is in a liquid state at some stage of processing, perhaps Celite can help you solve the quality versus production problem. A Celite engineer can give you the answer fast.

To get in touch with a Celite engineer or obtain further information on Celite diatomite filtration, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products.

**Johns-Manville CELITE FILTER AIDS**


Seacret Number 6
did you know?
. . . that SeaKem "Colloids Out of the Sea"* add viscosity to many solutions at very low concentrations. In addition, solutions of SeaKem Colloids are ionized, resulting in a negatively charged polymer having interesting interactions with proteins and other large molecules. This characteristic sometimes makes them particularly useful at extremely low cost in products containing milk solids.
*SeaKem is the registered trademark for the standardized hydrocolloids obtained from Irish Moss by the Seaplant Chemical Corporation. Extracted and refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem Colloids are light amber to colorless, free-flowing powders. Available in a variety of types suitable for a wide range of stabilizing functions, SeaKem Irish Moss Extractives have won acceptance with leading food manufacturers on the basis of their unique contributions to product improvement problems.
See us at Booth No. 62, Food Technology Meeting, Columbus, June 12-16
Seaplant CHEMICAL CORPORATION
63 David Street, New Bedford, Mass.


## FOOD INDUSTRY TOPICS

(Continued from page 52)

Bristol Co., Waterbury 20, Conn. Shown are float-type, pressure-type, differential pressure-type, and bubbler-type liquid and water level gauges in strip and round chart models. Air or electric controllers available in several modes.

◆ ◆ ◆

Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif., is offering new Bulletin P56 on the Cary Model 30 Vibrating Reed Electrometer, used for radioactivity measurements, $C^{14}$, $H^3$, $S^{35}$ determinations, mass spectrometry, electrical property measurements, and similar applications where very small currents, charges, and voltages are measured.

◆ ◆ ◆

The process industry applications of aluminum are thoroughly analyzed in a new 80-page book published by Aluminum Company of America, 761 Alcoa Bldg., Pittsburgh 19, Pa. The book, "Process Industries Applications of Alcoa Aluminum," delivers its story in 3 important phases: 1) process applications of aluminum by industry and product; 2) a comprehensive directory of performance of aluminum with various chemicals; and 3) latest information on designing aluminum processing equipment.

◆ ◆ ◆

Baldwin SR-4 Load Cells and Load Beams for electrical measurement of weight and force are presented in new 20-page Bulletin No. 4301 by Baldwin-Lima-Hamilton Corp., Philadelphia. Principles of measurement, specifications of load sensitive devices, available instrumentation, and typical applications are included. Write the company c/o Ketchum, MacLeod & Grove, Inc., 411 Seventh Ave., Pittsburgh 19, Pa.

***. . . building up and branching out***

Wallace & Tiernan, Inc., Belleville, N. J., through its wholly owned subsidiary, American Pacrite Corp., has acquired majority stock interest in American Machinery Corporation of Orlando, Fla., it was announced by Mr. R. M. Jackson, W&T executive vice president. American Machinery manufactures various types of equipment and materials used in processing foods such as citrus, tomatoes, potatoes, beans, cucumbers, etc. These products complement the W&T Decco process for reduction of transit and storage spoilage losses in fresh produce.

◆ ◆ ◆

Atlas Powder Co., Wilmington, Del., and Honeywill & Stein Ltd., British chemicals firm, announce formation of a jointly owned company, Honeywill-Atlas Ltd., according to a statement by Atlas president Ralph K. Gottshall. The new firm will make available from sterling sources sorbitol and a wide range of sorbitol derivatives and other surface-active agents developed by Atlas. Honeywill-Atlas Ltd. will headquarter at Devonshire House, London W. 1, with Mr. L. F. Harris as manager. Atlas also recently dedicated its new food emulsifier plant in Memphis, Tenn.

◆ ◆ ◆

A doubling of Sun Chemical Corporation's $40,000,000 sales volume within the next 10 years was described as management's objective at the firm's recent annual sales meeting by Mr. Ralph C. Persons, president. "This increase will result from Sun Chemical's obtaining a greater share of these markets available to its products," stated Mr. Persons. He pointed to growing use of color in all aspects of everyday life. "This trend has resulted in each of Sun Chemical's 3 product groups (Graphic Arts; Structural Waterproofing, Paint, and Products Finishing; and Chemical) increasing their sales of materials used to inject color into what were formerly drab or colorless products."

◆ ◆ ◆

"Summertime Is Tuna Time" will theme a nationwide promotion June 2-11. Spearheaded by the Tuna Research Foundation, the promotion will receive the full support and cooperation of the Fish and Wildlife Service, the Dept. of the Interior, and the Dept. of Agriculture.

◆ ◆

Merory Flavors, Inc., 697 Route 46, Clifton, N. J., announces it has been given exclusive representation for Cognac Oil of Eckes, made by the firm of Peter Eckes, Nieder-Olm bei Mainz, Germany, internationally known as makers of cognac oil. Eckes' Cognac Oil is made from the fermented remains of Rhine wines. The yeast of these wines reportedly yields the most superior flavor.

◆ ◆ ◆

A commercial sales division to handle sale of bulk products has been established by Carnation Co., 5045

**SANITATION**
starts with
**IN-PLANT CHLORINATION**

From start to finish of your processing operation, *Wallace & Tiernan In-Plant Chlorination* will keep your sanitation problems to a minimum by:

Eliminating slime formation on equipment and in work areas

Retarding bacteria growth

Greatly reducing offensive odors

For information on how In-Plant Chlorination can help solve *your* sanitation problems, write today to our Foods Division.

WALLACE & TIERNAN
INCORPORATED
25 MAIN STREET BELLEVILLE 9, N. J.

I-46


Wilshire Blvd., Los Angeles. Mr. Paul A. Taylor has been named manager of the new division, and Mr. Arthur C. Wiesenberger assistant manager. Mr. John T. Cunningham will be midwest manager with offices in Chicago.

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Dr. Robert E. Hulse, vice president and director of National Distillers Products Corp., announced that all chemical operations of the firm will be conducted by the U. S. Industrial Chemicals Co. Division of the Corporation. The change, according to Dr. Hulse, is one primarily of company name and internal organization.

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B. Heller & Co., manufacturing chemists, Calumet Avenue at 40th St., Chicago, announces purchase of the complete facilities of Conrad-Western laboratories. Located in Compton, a suburb of Los Angeles, Conrad-Western has a reputation for fine products for the meat packing industry. It will be operated as a separate corporation under the name of B. Heller & Company, Conrad-Western Laboratories Division.

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Production of steel shipping pails for southern manufacturers began on March 3 on new facilities of Jones & Laughlin Steel Corp., at 1280 Chattahoochee Ave., N. W. Atlanta, Ga. The new pail line, installed in J&L's Container Division Plant, produces lacquer-lined and decorated steel shipping pails in 3½- or 5-gallon capacity for paint and varnish, foods, oil and chemicals, soaps, shortenings, etc. J&L's other pail line is at Lancaster, Pa.

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Mr. Geo. L. Schultz, president of Shulton, Inc., Clifton, N. J., has announced acquisition of the major assets of A. Maschmeijer, Jr., Inc., of Newark, N. J. The business will be operated as the A. Maschmeijer, Jr., Division of Shulton, Inc., and represents a further expansion by Shulton, Inc., into the fine chemicals and pharmaceutical fields. Division operations will remain in Newark under the same personnel. Aromatic sales will be handled from offices at 630 Fifth Ave., New York, N. Y. Sales of pharmaceutical products will continue to be handled through Gane and Ingram, Inc., 43 W. 16th St., New York City 11.

***. . . meeting hall and conference room***

Pictured at the March 30-April 2 international sales meeting of the Felton Chemical Co., Brooklyn, N. Y., are the following executives and sales personnel of the flavor firm: front row, l. to r.—R. E. Felton, director of research and development, L. Howard, J. L. Weisman, L. Gampert, Sophie Felton, secretary and treasurer, Dr. Joseph Felton, president, F. Brumburgh, and J. Colton. Second row, l. to r.—G. Liebel, M. Zulauf, A. Lewis, D. W. Zuckerman, I. Kapp, Ruth Standen, R. I. Burke, Dr. H. Field, J. Kaufman, S. Eskanazy, L. C. Weinrobe, A. Dingfelder, H. Shore, and H. F. Dresel. Third row, l. to r.—M. Siegel, E. Barbeau, A. Kirsten, E. Petersen, H. Berger, W. Stone, J. P. Baude, P. Weinrobe, L. Allen, A. Dubenchick, D. Merso.

◆ ◆ ◆

The Committee on Vacuum Techniques, Inc., Box 1282, Boston 9, Mass., invites presentation of papers at the Second Symposium on Vacuum Technology to be held at Mellon Institute, Pittsburgh, Pa., October 13-15, 1955. The program will deal with equipment, instrumentation, fundamental developments in vacuum technology, standards, nomenclature, methods and techniques, and vacuum systems applications and processes. Contact Mr. Rudy Koehler.

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Announcement of election of officers for the 1955-56 term was made at the 46th annual meeting of the American Oil Chemists' Society, New Orleans, La. They are: president, W. A. Peterson, Colgate-Palmolive Co., Jersey City, N. J.; vice president, T. H. Hopper, Southern Regional Research Laboratory, USDA, New Orleans; secretary, R. W. Bates, Armour and Company, Chicago; and treasurer, A. F. Kapecki, Wurster and Sanger, Inc., Chicago.

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Also from the AOCS comes news that "Analytical Techniques" will be the theme for the 7th Annual

## FOOD INDUSTRY TOPICS

Short Course to be held at University of Illinois, Urbana, August 1-5, 1955. Outstanding chemists from industry, universities, and research institutions will conduct the 5-day course designed for laboratory workers in the field of fats and oils. Registration forms can be obtained from the Society's office, 35 E. Wacker Dr., Chicago 1, Ill.

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At the 1955 Fibre Box Exhibit, sponsored by The Fibre Box Assn., and held at Chicago's Edgewater Beach Hotel April 19-20, growth of the Association in its 15 years of existence from a few firms in 1940 to present membership of 147 U. S. box manufacturers was cited. It was also pointed out that in 1953, latest year for which figures are available, the food industry was by far the nation's largest user of corrugated and solid fibre boxes with a percentage of 30.7%.

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More than half of the available display space at Miami's Dinner Key Exhibit building—site of the American Bottlers of Carbonated Beverages industry exposition for 1955, November 14-17—has been reserved by members of the first of 5 groups of prospective exhibitors. Companies in "Group I" have participated for over 15 consecutive years in A. B. C. B. expositions. Choice of remaining space will go to those having participation records ranging from 10-15, 5-10, and 1-5 years, respectively. After that, any remaining exhibit space will be thrown open to Group V—newcomers who have indicated interest in contacting soft drink industry buyers at their annual exposition.

### . . . *the human element*

**Four members of the sales staff of Givaudan-Delawanna, Inc., and its associate companies, Givaudan Flavors, Inc., and Sindar Corp., recently celebrated their 25th anniversary with the company. This brought to 57 the number of 25-year Givaudan employees. At the banquet on February 18, culminating a 4-day sales conference, gold watches were presented to MR. BENJAMIN S. COTTLE, Givaudan's West Coast representative. MR. LYLE L. LOWDEN, New York area representative; MR. WALTER TOMZAK, representative in the metropolitan area; and MR. E. R. VAN LIEW, manager of Givaudan's Specialties Division. Pictured above during the presentation are, from left: Mr. H. F. Duffy, Givaudan treasurer; Mr. Tomzak; Mr. E. R. Durrer, president; Mr. Van Liew; Mr. Cottle; Mr. R. E. Horsey, vice-president in charge of sales; and Mr. Lowden.**

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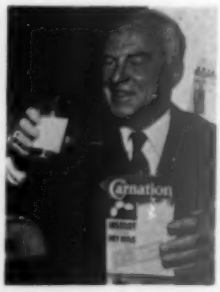
Ungerer & Company, Inc., 161 Avenue of the Americas, New York 13, N. Y., announces the following recent appointments: to vice president—**Mr. Geo. V. Branigan,** with the firm since 1922; to vice president and technical director — **Dr. Darrell Althausen,** a member of IFT and regarded as an outstanding authority in the fields of aromatic chemicals, essential oils, and flavors, who previously was technical director at the Ungerer Totowa, N. J., plant; to assistant secretary— **Mrs. Hazel F. Leiste;** to sales representative for New York state exclusive of New York City—**Mr. Wm. A. Kissel;** to Chicago District Sales Manager—**Mr. J. L. Slais;** and to sales representative for Connecticut with additional responsibilities in New York state—**Mr. Norman E. Gallagher.**

◆ ◆ ◆

**Mr. David D. Peebles,** dairy scientist and inventor who developed the "magic crystals" process used to produce Carnation Instant non-fat dry milk solids, will receive the 1955 biennial Food Technology Award for his achievement on June 13 at the Annual Meeting of IFT in Columbus, O. The instant milk process, involving a new "time-temperature-moisture" manufacturing operation, was introduced as Carnation Instant in the fall of 1954, and has since achieved national distribution. The award jury was chairmanned by Dr. Samuel C. Prescott and 14 other leading food technologists appointed by IFT. Sponsor of the award is *Food Engineering.*

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## FOOD INDUSTRY TOPICS

Appointment of **Dr. M. J. Blish,** nationally known food chemist and a member of IFT, as research consultant and coordinator to head an industry research program has been announced by the Glutamate Manufacturers' Technical Committee (G. M. T. C.). Membership is limited to research and technical service representatives of U.S. producers of monosodium glutamate, food flavor enhancer. Participating firms are the Huron Milling Co., A. E. Staley Mfg. Co., General Mills, Inc., International Minerals and Chemical Corp., and The Great Western Sugar Co. IFT member **C. F. Evers** is G. M. T. C. chairman.

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**Miss Beth Allen** has joined the technical staff of Dodge & Olcott, Inc. A specialist in foods and nutrition, Miss Allen will work in the new test kitchen under construction at the Hawthorne, N. J., plant. She will be available for special customer consultation on seasoning problems when such services are desired.

D&O also announces addition of **Dr. Olindo Secondini,** distinguished international chemist. Born and educated in Italy, where he received his degree and doctorate, he has worked in Chile, Guatemala, and the U. S. He will work in the D&O New York laboratories.

◆ ◆ ◆

The Minute Maid Corporation has named **Miss Eleanor M. Crozier** director of its newly organized Home Economics Dept., it was announced by Mr. Ambrose E. Stevens, vice president. Miss Crozier, well known as a food authority and home economist, is secretary of the New York Section of IFT.

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**Dr. Hans Schinz** of Firmenich & Cie., Geneva, Switzerland, producers of organic synthetics for perfumes and flavors, received the 1955 Fritzsche Award and Gold Medal at the General Assembly of the American Chemical Society in Cincinnati, O. The Society cited Dr. Schinz, noted for his extensive chemical studies of the oils from violets, for his valuable contributions to the chemistry of essential oils. The Award consists of $1000 and a gold medal.

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Mr. R. A. Bristol, director in charge of over-all sales activities of The Foxboro Co., Foxboro, Mass., announced appointments of **Mr. C. C. Fuller** as vice president, augmenting the sales management staff, **Mr. H. O. Ehrisman** as general sales manager, and **Mr. J. J. Burnett** as field sales manager. **Mr. C. Schwarzler** will continue to direct Foxboro's expanding international operations. Vice President **C. E. Sullivan,** who has retired from active sales direction, will serve in a consulting capacity with the sales organization. Also announced was formation of a sales product development committee headed by Mr. Fuller, and a sales policy committee with Mr. Ehrisman as chairman, further coordinating the firm's sales engineering and manufacturing functions.

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The Engineering Department of Foster D. Snell, Inc., New York City, announces appointment to its staff of **Mr. Wilbert A. Heyman,** pioneer in the soluble coffee field. This association will permit Snell to offer more comprehensive services in design, erection, and initial operation of soluble coffee plants. Mr. Heyman owns several patents on soluble coffee processing. In 1941, he erected and operated a plant which supplied over $2,000,000 worth of soluble coffee to the U. S. Armed Forces.

◆ ◆ ◆

**Mr. A. von Gontard,** vice president and director of Sales and Advertising of Anheuser-Busch, Inc., has been elected vice chairman of the Board of Directors and chairman of its Executive Committee, it was announced by Mr. August A. Busch, Jr., president. Mr. von Gontard has been with Anheuser-Busch since 1923, and a vice president since 1934.


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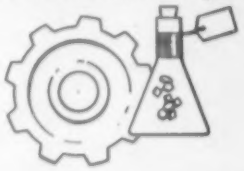

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**OPENING** on technical staff of New Jersey pharmaceutical and fine chemicals firm for person with Ph.D. in Chemistry or Food Technology or equivalent experience. Involves participation in and supervision of research and development in Food Technology including application of chemicals, vitamins and antibiotics for enrichment, preservation and improvement of foods. Important aspect involves development of assay methods for foods and feeds and supervision of such work. REPLY BOX 413, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

**AVAILABLE: PRODUCTION AND RESEARCH CHEMIST,** with extensive and diversified experience in production, supervision, development and control of confectionery, desserts, cereal products, chocolate, ice cream, and other food products. Desires position of responsibility. REPLY BOX 415, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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Our personnel informed of this opening. Send résumé and initial salary desired. Strictest confidence observed. BOX 414, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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**AVAILABLE:** Food Chemist, B.S., '49 Grad., 6 yrs. exper. manufacturing and product development in preserving and dry mix field. Presently employed as Chief Chemist and Asst. Supt. Technical sales or similar to present position. 29 yrs. old, married. Salary open. REPLY BOX 404, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

**WANTED: FOOD TECHNOLOGIST**—$12,000. Top level administrative position in Central Quality Control with Multi-plant "beverage" organization. Close knowledge of procedures, controls, and standards for sanitation and quality control of raw materials and finished products. Candidate should have a proven record of success administratively, and possess a Chemistry or Chemical Engr'g degree. REPLY BOX 411, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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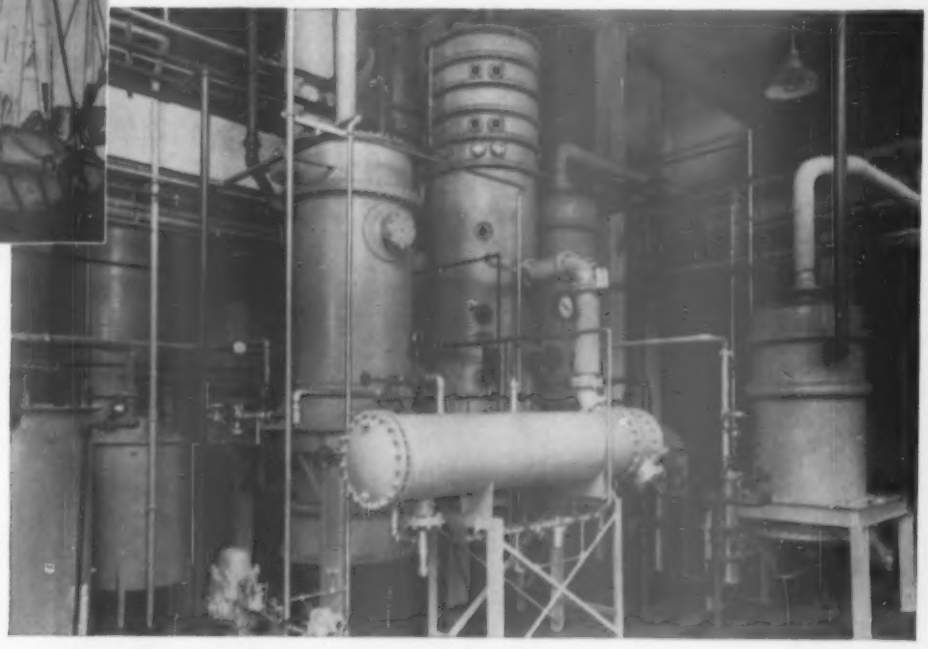

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